
CLAIMS

[Claim(s)]
[Claim 1] It is the semiconductor device characterized by being the semiconductor device which has the light sensing portion which changes into an electrical signal the light which spreads an optical transmission field and this optical transmission field, constituting this optical transmission field including the two-dimensional mold optical waveguide layer, and embedding this a part of light sensing portion [at least] to this optical transmission field.
[Claim 2] The semiconductor device according to claim 1 with which the laminating of the electric wiring layer is carried out on said optical transmission field.
[Claim 3] Said light sensing portion is a semiconductor device according to claim 1 currently embedded to this optical transmission field so that direct light-receiving of the light which spreads the inside of said two-dimensional mold optical waveguide layer may be possible.
[Claim 4] Said light sensing portion is a semiconductor device according to claim 1 currently embedded so that the light which spreads the inside of the field of said two-dimensional mold optical waveguide layer can be received without directivity.
[Claim 5] The semiconductor device according to claim 1 which has the field where the part currently embedded to said optical transmission field of said light sensing portion is spherical.
[Claim 6] Said light sensing portion is a semiconductor device according to claim 1 constituted including the spherical device.
[Claim 7] The semiconductor device according to claim 1 with which the part is embedded also for the light-emitting part for transmitting light to said optical transmission field to this optical transmission field.
[Claim 8] It is the semiconductor device according to claim 2 which said electric wiring layer located on this optical transmission field and another electric wiring layer located under this optical transmission field face across said optical transmission field, and is characterized by the beer with which a part of electric wiring layer [at least] pierces through this optical transmission field mutually connecting electrically.
[Claim 9] The semiconductor device according to claim 2 with which either [at least] O/E conversion with the electron device formed on said electric wiring layer and said optical transmission field or E/O conversion is performed using a spherical device.
[Claim 10] It is the substrate with which the electron device and the optical device have been arranged, and consists of two-layer at least. To the 1st layer of this substrate The electric wiring which combines said electron device, said optical device, and these is arranged. It is the photoelectrical fusion substrate which two-dimensional mold optical waveguide is formed in the 2nd layer of this substrate, and said optical device has the light sensing portion which receives the light which is guiding this two-dimensional mold optical waveguide, and is characterized by embedding this a part of light sensing portion [at least] at this two-dimensional mold optical waveguide.
[Claim 11] The photoelectrical fusion substrate according to claim 10 with which said two-dimensional mold optical waveguide is characterized by being formed in the shape of a sheet.

[Claim 12] It is the photoelectrical fusion substrate according to claim 10 characterized by for said light sensing portion having spherical structure, and mounting this light sensing portion from this substrate front face so that it may be embedded at said optical waveguide, and having combined with said electric wiring on the front face of this substrate.
[Claim 13] The photoelectrical fusion substrate according to claim 10 characterized by forming the electrical circuit which drives a light sensing portion and this to said optical device, or amplifies the electrical signal acquired.
[Claim 14] The photoelectrical fusion substrate according to claim 10 characterized by having mounted the light source in this substrate from the front face so that a spherical configuration might be embedded at said optical waveguide of nothing and said substrate, and having combined with said electric wiring on the front face of this substrate among said optical devices.
[Claim 15] The photoelectrical fusion substrate according to claim 10 which said optical device is spherical structure and is characterized by accumulating the electronic circuitry which drives the light source, an electric eye, and them to this optical device.
[Claim 16] Said substrate is a photoelectrical fusion substrate according to claim 10 which is having the device for transmission and parallel signal line of spherical structure, and the output terminal of this parallel signal line being combined with said device for spherical transmission, and carrying out parallel serial conversion with this device for transmission, and is characterized by sending out to said two-dimensional mold optical waveguide as a serial lightwave signal.
[Claim 17] The photoelectrical fusion wiring substrate according to claim 16 characterized by for serial/parallel conversion being carried out to this light sensing portion by the electronic circuitry formed simultaneously, and being transmitted to said parallel signal line after receiving said serial lightwave signal by said light sensing portion embedded at said two-dimensional mold optical waveguide and being changed into an electrical signal.
[Claim 18] The photoelectrical fusion substrate according to claim 10 with which said photoelectrical fusion substrate consists of substrate ingredients with flexibility.
[Claim 19] The photoelectrical fusion integrated circuit characterized by having at least the amplifier which amplifies the bias circuit where it is the photoelectrical fusion integrated circuit with which the electron device and the optical device were accumulated on the spherical semi-conductor substrate front face, this optical device is the photo detector constituted including the multilayer which includes pn junction radially, and this electron device applies a reverse bias to this photo detector, and the signal which received light and was changed into the electrical signal.
[Claim 20] The photoelectrical fusion integrated circuit according to claim 19 with which said a part of photo detector [at least] is embedded at the optical transmission medium.
[Claim 21] The photoelectrical fusion integrated circuit according to claim 19 characterized by said spherical semi-conductor substrate consisting of Si single crystals.
[Claim 22] The photoelectrical fusion integrated circuit according to claim 19 characterized by said spherical semi-conductor substrate consisting of GaAs single crystals.
[Claim 23] The photoelectrical fusion integrated circuit according to claim 19 with which the multilayer which constitutes said photo detector is characterized by consisting of p-Si, i-Si, and n-Si.
[Claim 24] The photoelectrical fusion integrated circuit according to claim 19 with which the multilayer which constitutes said photo detector is characterized by consisting of p-GaAs, GaAsN, and n-GaAs.
[Claim 25] The manufacture approach of the photoelectrical fusion integrated circuit according to claim 19 characterized by the approach of producing the multilayer which constitutes said photo detector being what depended on ion-implantation.
[Claim 26] The photoelectrical fusion integrated circuit with which it is the photoelectrical fusion integrated circuit with which the electron device and the optical device were accumulated on the spherical semi-conductor substrate front face, this optical device is the light emitting device constituted including the multilayer which includes pn junction radially, and this electron device is characterized by having the bias circuit which applies forward bias to this light emitting device.
[Claim 27] The photoelectrical fusion integrated circuit according to claim 26 with which said a part of

light emitting device [at least] is embedded at the optical transmission medium.
[Claim 28] After it is the photoelectrical fusion integrated circuit with which the electron device and the optical device were accumulated on the spherical semi-conductor substrate front face, and this optical device carries out flattening of said a part of spherical semi-conductor front face and sends two or more minute flat surfaces, The photoelectrical fusion integrated circuit characterized by having at least the bias circuit where the laminating of the multilayer including pn junction is carried out, it is formed on this minute flat surface, and this electron device applies a reverse bias or forward bias to this.
[Claim 29] The photoelectrical fusion integrated circuit according to claim 23 with which said optical device is embedded at the optical transmission medium.
[Claim 30] The photoelectrical fusion integrated circuit according to claim 28 characterized by said spherical semi-conductor substrate consisting of Si single crystals.
[Claim 31] The photoelectrical fusion integrated circuit according to claim 28 characterized by said spherical semi-conductor substrate consisting of GaAs single crystals.
[Claim 32] The photoelectrical fusion integrated circuit of the account of claim 28 publication characterized by said spherical semi-conductor substrate consisting of InP single crystals.
[Claim 33] The photoelectrical fusion integrated circuit according to claim 28 characterized by said spherical semi-conductor substrate consisting of GaN single crystals.
[Claim 34] The photoelectrical fusion integrated circuit according to claim 28 with which a multilayer including said pn junction is characterized by consisting of p- (aluminum, Ga) (As, P, N), i- (aluminum, Ga) (As, P, N), and n- (aluminum, Ga) (As, P, N).
[Claim 35] In the process which carries out the laminating of the multilayer which includes pn junction radially on this minute flat surface after carrying out flattening of said a part of spherical semi-conductor front face and sending two or more minute flat surfaces The manufacture approach of the photoelectrical induction integrated circuit according to claim 28 characterized by carrying out the laminating of the multilayer which covers fields other than the minute flat surface of said spherical semi-conductor front face with a dielectric film etc., and includes said pn junction selectively only at a minute flat surface with an organic metal epitaxial grown method or gas source molecular-beam vacuum deposition.
[Claim 36] The manufacture approach of a photoelectrical fusion integrated circuit according to claim 28 that the minute flat surface which comes to carry out flattening of said a part of spherical semi-conductor front face is characterized by equivalence or consisting of the near crystal face chemically at a crystal engineering target.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the semiconductor device which the optical transmission medium and the photo detector which performs photo electric translation loaded together. Especially, this optical transmission medium is related with the photoelectrical fusion substrate which consists of two-dimensional mold optical waveguides. Moreover, this invention relates to the photoelectrical fusion wiring substrate which has an electric wiring layer and an optical transmission layer. Moreover, this invention relates to a spherical device.
[0002]
[Description of the Prior Art] To the cellular phone with which spread remarkable in recent years is conspicuous, or an individual humanity news terminal (PDA:Personal DigitalAssitant), it is called for that the processing speed of a transistor is small, lightweight, and dramatically high to coincidence.
[0003] It is pointed out that the effect of the wiring delay in an electronic-circuitry substrate becomes large as the clock frequency of CPU goes up as the processing speed of a transistor increases namely.
[0004] Since wiring delay is proportional to the product of wiring resistance and wiring capacity, reduction of wiring resistance or wiring capacity is needed.
[0005] As a cure against wiring delay, it becomes the simplest cure approach to shorten wiring in a chip and between a chip as much as possible.
[0006] On the other hand, if wiring spacing becomes short, although the improvement in processing speed is expectable, another trouble actualizes.
[0007] It is the problem of EMI (electromagnetic-radiation interference noise: ElectroMagnetic Interference).
[0008] A wiring consistency becomes high, although wiring becomes short since electronic parts approach and they are arranged.
[0009] When a high-speed signal flows to the signal line which approached, an electromagnetic wave interferes each other by mutual electromagnetic induction, a noise is generated, and it becomes impossible consequently, for a signal to transmit correctly.
[0010] The cases conventionally driven by the high current are increasing in number under the effect to which low-battery-ization especially progresses at a mobile terminal, and we are anxious about the effect of EMI becoming larger.
[0011] in order to solve the problem of EMI -- essential -- electromagnetism -- the approach using optical wiring which has a non-guided advantage is proposed.
[0012] For example, the circuit board by which the electronic device and the light corpuscle child were integrated as shown in drawing 35 is shown in JP,2000-235127,A.
[0013] For 5201, as for a light-emitting part, 5206 light sensing portions, and 5207, in this drawing, an electronic integrated-circuit substrate and 5204 are [an optical-path converter and 5210] contact electrodes. 5211 is polyimide for making the circuit board 5201, and a light-emitting part and a light sensing portion rival. 5212 -- electric wiring and 5213 -- for a low reflecting layer and 5216, as for the

1st cladding layer and 5218, a polymer layer and 5217 are [a surface emission-type laser and 5214 / a photodiode and 5215 / a core layer and 5219] the 2nd cladding layer and the 5220 high reflective film.
[0014] The light inputted from the light-emitting part 5213 is received by the light sensing portion 5206, after being reflected by the optical-path converter, spreading the inside of a core layer 5218 in the direction of the arrow head 5221 in drawing and carrying out optical-path conversion again.
[0015] When the direction which input light spreads beforehand is defined, the configuration shown in above-mentioned drawing 35 can also transpose some electrical signal wiring to optical wiring.
[0016]
[Problem(s) to be Solved by the Invention] However, in the case of the light from 5222 directions where the input light which spreads a core layer 5218 is shown by the arrow head all over drawing, for example, light cannot be received with the configuration of this drawing.
[0017] Then, in case this invention receives the light which spreads an optical transmission field, it aims at offering the semiconductor device which reduced direction dependency.
[0018] In addition, this invention also makes it the object to offer the luminescence device or light-receiving device which can be contributed to reduction of direction dependency (directivity).
[0019]
[Means for Solving the Problem] The photoelectron fusion equipment concerning this invention is photoelectron fusion equipment which has the light sensing portion which changes into an electrical signal the light which spreads an optical transmission field and this optical transmission field, and it is characterized by constituting this optical transmission field including the two-dimensional mold optical waveguide layer, and embedding this a part of light sensing portion [at least] to this optical transmission field.
[0020] The direction dependency of light-receiving sensibility at the time of receiving the light which spreads an optical transmission field by this invention can be reduced.
[0021] Moreover, in this invention, the laminating of the electric wiring layer can also be carried out on said optical transmission field. The laminating of the electric wiring layer may be carried out the whole surface on an optical transmission field. Of course, the laminating of the so-called semiconductor chip containing electric wiring can also be carried out on an optical transmission field. Said light sensing portion will intervene between a semiconductor chip and an optical transmission field at this case.
[0022] In addition, when a light sensing portion has a pn junction field and an PIN field, it is good to embed a part of field [at least] concerned to said optical transmission field. Of course, all of the fields concerned may be embedded substantially.
[0023] Said light sensing portion may be embedded to this optical transmission field so that direct light-receiving of the light which spreads the inside of said two-dimensional mold optical waveguide layer may be possible.
[0024] Said light sensing portion can also be embedded so that the light which spreads the inside of the field of said two-dimensional mold optical waveguide layer can be substantially received without directivity.
[0025] The part currently embedded to said optical transmission field of said light sensing portion is good to have the spherical field.
[0026] Said light sensing portion may be constituted including the spherical device.
[0027] The light-emitting part for transmitting light to said optical transmission field can also embed the part to this optical transmission field.
[0028] Said electric wiring layer located on this optical transmission field and another electric wiring layer located under this optical transmission field face across said optical transmission field, and, as for a part of mutual electric wiring layer [at least], it is also desirable that the beer which pierces through this optical transmission field connects electrically.
[0029] Either [at least] O/E conversion with the electron device formed on said electric wiring layer and said optical transmission field or E/O conversion can also be performed using a spherical device.
[0030] The photoelectrical fusion substrate concerning this invention is a substrate with which the electron device and the optical device have been arranged, and consists of two-layer at least. Moreover,

to the 1st layer of this substrate The electric wiring which combines said electron device, said optical device, and these is arranged. Two-dimensional mold optical waveguide is formed in the 2nd layer of this substrate, said optical device has the light sensing portion which receives the light which is guiding this two-dimensional mold optical waveguide, and it is characterized by embedding this a part of light sensing portion [at least] at this two-dimensional mold optical waveguide.
[0031] Said two-dimensional mold optical waveguide may be formed in the shape of a sheet.
[0032] Said light sensing portion has spherical structure, and this light sensing portion is mounted from this substrate front face so that it may be embedded at said optical waveguide, and on the front face of this substrate, said electric wiring and association, now Lycium chinense grow in it.
[0033] The electrical circuit which drives a light sensing portion and this to said optical device, or amplifies the electrical signal acquired may be formed.
[0034] Among said optical devices, the light source was mounted in this substrate from the front face so that a spherical configuration might be embedded at said optical waveguide of nothing and said substrate, and it may combine with said electric wiring on the front face of this substrate. It has the device for transmission and parallel signal line of spherical structure, and the output terminal of this parallel signal line is combined with said device for spherical transmission, and said substrate is carrying out parallel serial conversion with this device for transmission, and can also be sent out to said two-dimensional mold optical waveguide as a serial lightwave signal.
[0035] After receiving said serial lightwave signal by said light sensing portion embedded at said two-dimensional mold optical waveguide and being changed into an electrical signal, it can also be characterized by for serial/parallel conversion being carried out to this light sensing portion by the electronic circuitry formed simultaneously, and being transmitted to said parallel signal line.
[0036] Said photoelectrical fusion substrate can also consist of substrate ingredients (flexible sheet) with flexibility.
[0037] The photoelectrical fusion integrated circuit concerning this invention is a photoelectrical fusion integrated circuit with which the electron device and the optical device were accumulated on the spherical semi-conductor substrate front face, and this optical device is the photo detector constituted including the multilayer which includes pn junction radially, and it is characterized by having at least the amplifier with which this electron device amplifies the bias circuit which applies a reverse bias to this photo detector, and the signal which received light and was changed into the electrical signal.
[0038] Moreover, the electron device and the optical device are accumulated on the spherical semi-conductor substrate front face, this optical device is the light emitting device constituted including the multilayer which includes pn junction radially, and the photoelectrical fusion integrated circuit concerning this invention is characterized by having the bias circuit where this electron device applies forward bias to this light emitting device.
[0039] Moreover, after, as for the photoelectrical fusion integrated circuit concerning this invention, the electron device and the optical device are accumulated on the spherical semi-conductor substrate front face, and this optical device carries out flattening of said a part of spherical semi-conductor front face and sends two or more minute flat surfaces, On this minute flat surface, the laminating of the multilayer which includes pn junction radially is carried out, it is formed, and this electron device is characterized by having at least the bias circuit which applies a reverse bias or forward bias to this.
[0040] After carrying out flattening of said a part of spherical semi-conductor front face and sending two or more minute flat surfaces, in the process which carries out the laminating of the multilayer which includes pn junction radially on this minute flat surface, fields other than the minute flat surface of said spherical semi-conductor front face can be covered with a dielectric film etc., and the laminating of the multilayer which includes said pn junction selectively only at a minute flat surface with an organic metal epitaxial grown method or gas source molecular-beam vacuum deposition can be carried out.
[0041] The minute flat surface which comes to carry out flattening of said a part of spherical semi-conductor front face may be constituted from the crystal face near equivalence or a chemistry target by the crystal engineering target.
[0042]

[Embodiment of the Invention] The operation gestalt of this invention is explained using drawing 1 .
[0043] In drawing 1 , the optical transmission field where 1000 is constituted including the optical waveguide layer of a two-dimensional mold, and 1010 are light sensing portions which receive the light which spreads this optical transmission field. The sectional view in AA' in drawing 1 is drawing 2 .
[0044] As shown in drawing 2 , offer of the semiconductor device which reduced the direction dependency of the light which this light sensing portion of the light which spreads an optical transmission field can receive by being embedded to the optical transmission field 1000 of a part of light sensing portion [at least] 1010 is attained.
[0045] An optical transmission field is formed by pinching a core layer by the cladding layer with a refractive index lower than this core layer. As an ingredient of a core layer, plastic material, such as optical plastics, such as PMMA (polymethylmethacrylate), a quartz system glass ingredient and polystyrene, and a polycarbonate, can be used. Although it is not limited as a cladding layer especially if a refractive index is lower than a core layer, polymer material, PCZ, ATON, etc. of fluorine content can be used, for example.
[0046] the line by which the propagation direction of light is beforehand determined to the one direction as the optical waveguide layer of a two-dimensional mold -- not waveguide but the waveguide of the shape of a field which can be spread in two or more directions of [within a field] is meant. In addition, in this invention, a two-dimensional mold optical waveguide layer may be called optical sheet.
[0047] A light sensing portion is the photo-electric-translation device which can perform O/E conversion. The photodiode of the so-called PN mold or an PIN mold is applicable. even if the PN-junction side is level on an optical sheet as a configuration of a light sensing portion -- abbreviation -- it may be vertical. It is good for the configuration of the light sensing portion of the part especially embedded to said optical transmission field to have a polyhedron or a spherical-surface configuration.
[0048] When embedding a light sensing portion to an optical transmission field, you may also embed a part of light sensing portion, and may also embed the all substantially. It is good to embed the PN-junction section at least at the core layer.
[0049] When the optical transmission field is constituted including the core layer and the cladding layer, it is good to embed the light sensing portion by Fukashi who reaches a core layer.
[0050] An electric wiring field can also be formed on the two-dimensional mold optical waveguide layer as an optical transmission field. The example is shown in drawing 3 .
[0051] In drawing 3 , it is the two-dimensional optical waveguide layer ("an optical sheet" is called hereafter.) by which 1101 was formed in the photoelectrical fusion substrate and 1102 was formed in the interior. The electron device (for example, they are CPU, RAM, a RF oscillator, etc.) with which 1103 and 1106 were formed on the electric wiring field 1108, the electric wiring by which 1104 was formed in the front face, and 1105 shown by the drawing Nakaya mark are optical wiring which the light which spreads the inside of said optical sheet forms. 1109 is a support substrate. Of course, what is necessary is just to form a support substrate if needed. Or the support substrate itself may function as a cladding layer. In this drawing, signs that a signal is transmitted to other electron devices 1107 etc. from an electron device 1106 using an optical sheet are shown.
[0052] For example, when optical wiring performs wiring to electron devices 1106-1107, the electrical signal from an electron device 1106 is changed into a lightwave signal by the E/O converter (not shown), and the optical sheet 1102 is made to diffuse the lightwave signal concerned. Although a lightwave signal is spread in the direction of an omnidirection within an optical sheet at a radial, it can also give a function to an optical sheet so that it may spread in the specific direction with which it is mainly concerned.
[0053] the lightwave signal which spread the inside of an optical sheet should pass an O/E converter (not shown) -- it is received by the electron device 1107. In this way, optical wiring is realized.
[0054] Moreover, by the original circuit pattern, in order to use the optical waveguide layer of a two-dimensional mold, even when the electron device 1107 does not exist, it can arrange in the location (for example, drawing 1) of the arbitration of the electric wiring field 1108. Of course, even if it calls it the location of arbitration, the free area for arranging an electron device 1107 is required.

[0055] And since the part is embedded at optical waveguide if there are few light sensing portions while being able to lessen effect of EMI by using optical wiring, it becomes possible to receive the signal light from various directions.
[0056] Furthermore, the light-emitting part which sends signal light to an optical sheet is also good to embed at least the part in an optical sheet again. The example is shown using drawing 4 . In this drawing, the electron device is drawn about the case where flip chip mounting is carried out. 1103 -- an electron device and 1104 -- for a metal bump and 1205, as for a core layer and 1207, an up cladding layer and 1206 are [a metal wiring field and 1201 / a light sensing portion and 1202 / a lower cladding layer and 1208] light-emitting parts. 1210 shows signs that the light to spread is received by the light sensing portion 1201. 1203 shows signs that the electrical signal which carried out O/E conversion of the light which received light by the light sensing portion is transmitted to an electron device. 1211 shows signs that the light which spreads the inside of a core layer 1206 from a light-emitting part 1208 is transmitted.
[0057] In drawing 4 , since a part of light-emitting part 1208 is embedded at a core layer 1206 and the spherical device (it mentions later for details.) is used, light spreads so that it may be spread in the field inboard in a core layer.
[0058] In addition, the production approach of Ball IC is performed as follows, for example.
(1) Produce Si ball first. The granular polycrystal Si is put in into a pipe with a diameter of 2mm, and is fused, and it is mostly made a globular form single crystal. Then, surface polish is performed in the way which produces a ball bearing, and it is made the real ball of 1mmphi.
(2) Next, it lets the inside of IC process pipe pass, and perform oxidation and a diffusion process. Pattern baking is realizable by the approach currently indicated by JP,10-294254,A and JP,11-54406,A. In the former, it has a circuit pattern corresponding to the spherical surface of Si ball ingredient, and one-shot exposure of this circuit pattern is carried out to the field more than one half of all the spherical surfaces over the spherical surface of this Si ball ingredient. In the latter, the exposure field of the spherical IC front face corresponding to this angle of rotation is exposed using the mask corresponding to this, fixing the shaft passing through the core of spherical IC to arbitration, and rotating spherical IC intermittently centering on this shaft. The Si ball IC is completed at the process so far.
[0059] In addition, to two-dimensional optical waveguide, effectively, light can also be additionally used for a mirror, prism, a grating, a hologram, etc., outgoing radiation or in case incidence is carried out.
[0060] In addition, as a spherical semi-conductor member used for this invention, it can constitute from ingredients, such as Si, GaAs, InP or GaN, germanium and AlN, SiGe, and GaAsN. Of course, although it is desirable that it is a single crystal as for these ingredients, when functioning enough as a light sensing portion or a light-emitting part, you may be polycrystal or an amorphous substance.
[0061] As a multilayer which constitutes said photo detector or light emitting device, it can constitute, for example from p-Si/i-Si/n-Si, can constitute from p-GaAs/GaAsN/n-GaAs, or can constitute from p-(aluminum, Ga) (As, P, N)/i-(aluminum, Ga) (As, P, N)/n- (aluminum, Ga) (As, P, N).
[0062] In addition, (C (A, B), D, E), in a publication, A and B show an III group element and C, D, and E show V group element. (A, B) A publication expresses AxB1-xCyDzE1-y-z (C, D, E).
[0063]
[Example] (Example 1: Optical sheet + spherical mold light-receiving device) The 1st example is explained using drawing 1 , drawing 2 , drawing 5 , and drawing 6 . PMMA which is optical plastics was used as a core layer of an optical transmission medium 1000. Polyimide was used as a cladding layer formed so that this core layer may be pinched. The thickness of the whole optical transmission medium was about 0.8mm (0.2mm of core layers, 0.3mm of cladding layers), and magnitude was 30x30mm. In addition, the concrete manufacture approach of an optical transmission medium is mentioned later.
[0064] A spherical device can be used as a light sensing portion 1010.
[0065] The typical sectional view of a spherical light device was shown in drawing 5 . In this drawing, 1501 is a spherical p mold Si member. In addition, the Si ball itself is obtained by performing surface

polish in the way which produces a ball bearing, and making it a real ball, after fusing for example, the granular polycrystal Si and making it a globular form single crystal mostly. On the spherical Si member 1501, as the 1st cladding layer 1502, it grows up considering P type AlGaAsN as a barrier layer 1503, and the n mold AlGaAsN is grown up as Undoping GaAsN and the 2nd cladding layer 1304.
[0066] The compound semiconductor of a GaAsN system was used here because it was easy to carry out lattice matching of the band gap to excelling in the temperature characteristic small to GaAs, and also Si.
[0067] Of course, a light sensing portion (photodiode) is produced not growing up a compound semiconductor thin film, growing up the silicon thin film of N type into a P type spherical silicon front face, and forming a PN junction on spherical Si. Moreover, ion-implantation and a diffusion method (thermal diffusion or solid phase diffusion) may be used instead of making a PN junction with thin film growth.
[0068] The anode 1505 electrically connected with the cathode 1504 through the beer hall 1506 is formed in the pole section of this ball IC. A beer hall 1506 can be formed by etching or laser processing.

[0069] A light sensing portion 1010 is embedded next at an optical transmission medium. As shown in drawing 6 , specifically, it embeds even at extent which reaches a cladding layer 1605 and a core layer 1606. 1607 is a cladding layer.
[0070] In order to embed a light sensing portion, it is necessary to make the hole corresponding to an embedding field in an optical transmission medium. the metal mold of the metal for drilling -- heat -- the hole corresponding to a light sensing portion is formed by pushing against an optical transmission medium the back the bottom. The semiconductor device said to this invention is done by embedding a light sensing portion 1010 in the formed hole. A light sensing portion 1010 is applying a reverse bias between a cathode 1504 and an anode 1505, and the light which carried out incidence is absorbed by the PN junction, and is obtained as an electrical signal.
[0071] As explained above, the semiconductor device with which the direction dependency (directivity) of the light which spreads an optical transmission medium was reduced remarkably is produced. Moreover, a light sensing portion can receive directly the light which has transmitted the optical transmission field.
[0072] In addition, although the spherical device was used as a light sensing portion, the usual photodiode which is not spherically limited if it can embed at an optical transmission medium, and has a PN junction may be used.
[0073] Moreover, with a light sensing portion, you may also produce a light-emitting part with a spherical device, and may also embed the part at an optical transmission medium. Furthermore, it is also possible to form an electric wiring layer on [whole] an optical sheet. The above-mentioned optical sheet is beforehand prepared in the lower layer of the printed circuit board for electric wiring, and it is also a desirable gestalt to carry out some wiring to optical wiring if needed.
[0074] (Example 2: The additional approach of an electron device) In view of the direction dependency of a light sensing portion being reduced in this invention, the additional approach of the following electron devices is possible.
[0075] It explains using drawing 9 from drawing 7 . In drawing 7 , 1750 shows the photoelectrical fusion substrate. As for an optical transmission medium and 1720, an electric wiring layer, and 1707 and 1705 is [1700] electron devices. 1705 is equipped with the light-emitting part (not shown) with possible making an optical transmission medium 1700 spread signal light. 1720 is an electric wiring layer (for example, printed circuit board).
[0076] If it does not have the optical transmission medium when newly adding an electron device 1706 to the photoelectrical fusion substrate 1750 at a free area 1730, an electron device 1706 only must be added and electric wiring must be performed between each devices. However, in the case of the photoelectrical fusion substrate 1750, optical wiring can be used for between an electron device 1705 and 1706. In drawing 7 , 1780 is a light sensing portion produced by the approach as stated above.
[0077] The optical transmission medium 1700 forms the hole for embedding beforehand, as shown in

drawing 8 . One or plural are sufficient as the embedding's hole. From a viewpoint of the degree of freedom of arrangement, it is good to form two or more holes beforehand. For example, a hole is formed in the shape of an array. In drawing 8 , 1741 is a hole to embed the light-emitting part of an electron device 1705. In addition, the hole 1744 which is not used can also be filled with resin etc. It is effective when the light which spreads the inside of an optical transmission medium is superfluously scattered about by the intact hole. In addition, it is also desirable to give a difference to the etching property of the resin which fills a hole, and its perimeter so that it may be easy to remove the packing of a hole.
[0078] In adding an electron device 1706 in this example, a hole 1740 is used.
[0079] As shown in drawing 9 , the field which is going to add an electron device 1706 is removed and a hole 1740 is exposed. Of course, this process can be skipped when the electric wiring layer 1720 is not formed in the field of 1730 shown in drawing 7 . Then, when packing is in a hole 1740, etching etc. removes it. And this device is added so that the light sensing portion 1780 of an electron device 1706 may be embedded in a hole 1740. An electron device 1705 becomes possible [connecting the part between 1706 with an electron device 1705 with optical wiring] using the optical transmission object 1700 which was not used until an electron device 1706 is added, since it has the light-emitting part.
[0080] When newly adding a device to a very small printed circuit board which is built in a cellular phone according to this example, optical wiring can be used and the effect of EMI accompanying addition of an electron device can be reduced.
[0081] When it is newly going to add an electron device on the assumption that the existing circuit pattern, the existing circuit group may be influenced of EMI with the electron device newly added. In this case, optical wiring can be used like this example.
[0082] Although optical wiring is possible also for a configuration as shown in drawing 35 if linear waveguide is beforehand formed corresponding to the location of the electron device newly added, now, the degree of freedom of arrangement will become very low. It is because the additional location of a new device is dependent on the linear waveguide location currently formed beforehand. By using the optical waveguide of a two-dimensional mold like this example, optical high wiring of the degree of freedom of device arrangement is attained.
[0083] (Example 3: Photoelectricity two-layer substrate + spherical light I/O device) Drawing 3 is a typical perspective view for explaining the example of this invention.
[0084] The two-dimensional optical waveguide layer ("an optical sheet" is called hereafter.) by which 1101 was formed in the photoelectrical fusion substrate and 1102 was formed in the interior in drawing 3 , the electron devices (for example, CPU, RAM, a RF oscillator, etc.) with which 1103, 1106, and 1107 were formed in the front face, the electric wiring by which 1104 was formed in the front face, and 1105 are optical wiring which the light which spreads the inside of said optical sheet forms.
[0085] First, the production approach of an optical sheet is explained.
[0086] Although the structures of an optical sheet will not be a predetermined distance and the thing limited about light especially if it can transmit, what fulfills the following conditions is more desirable.
(1) Have the two-dimensional slab mold optical waveguide which guides light.
[0087] Although propagation loss is better as it is small, it depends for it on a transmission distance. For example, if it is the thing of 0.1 dB/cm, the substrate of several cm angle can be used.
(2) Electric wiring is producible on a front face.
[0088] This is for employing the conventional electric circuit pattern efficiently as it is.
[0089] What fills the above (1) and (2) with using organic resin, such as polyimide, for an optical waveguide layer is obtained using PMMA as a support substrate and a cladding layer. In addition, as for an optical transmission layer, it is desirable to have prepared the whole surface under an electric wiring layer.
[0090] The sectional view in the B section in drawing 3 is shown in drawing 4 . An electron device 1103 explains the case where optical INTAKONEKUSHON is performed using the optical sheet 1102. In this drawing, the case where the light sensing portion 1201 and the light-emitting part 1208 have dissociated from the electron device 1103 is shown. Of course, the light sensing portion and the light-emitting part may be built in electron device 1103 the very thing.

[0091] As for a resin substrate (** cladding layer) and 1205, 1207 is [a cladding layer and 1206] core layers with a refractive index higher than 1205 and 1207. Although each thickness was made into 0.5mm of substrates, 0.1mm of core layers, and 0.3mm of cladding layers, it is not restricted to such sizes.
[0092] It is the optical sheet which unified these three layers. It can consider as a flexible substrate strong against bending by applying a core layer and a cladding layer and using the polyimide resin which can form membranes, using the PMMA substrate which has flexibility in a substrate.
[0093] In this example, the optical I/O device (spherical light device) formed with the compound semiconductor on the spherical Si substrate is used.
[0094] This spherical light device is explained briefly (the matter relevant to a spherical device is indicated by JP,12-31190,A).
[0095] The mimetic diagram of a spherical light device was shown in drawing 5 . As for a spherical p mold Si substrate and 1502, in this drawing, 1501 is [a P type AlGaAsN cladding layer, a 1503 undoping GaAsN barrier layer and 1504] n mold AlGaAsN cladding layers. It is [that one band gap is small excellent in the temperature characteristic, that it is easy to carry out lattice matching to 2Si, and] to have used the compound semiconductor of a GaAsN system here. Other ingredient systems including a substrate may be used.
[0096] The anode 1505 connected with the cathode 1504 through the beer hall 1506 is formed in the pole section of this ball IC. In this example, it is good also as structure which is different in a light emitting device and a photo detector although the thing of this structure was used. As for a cathode 1504, it is desirable to have aperture structure and mesh structure in order to output and input light.
[0097] In carrying out ball IC actuation as a light emitting device, by applying forward bias between a cathode 1504 and an anode 1505, a carrier is poured into a PN junction and emits light. The light which emitted light is emitted to a wide angle from an optical outgoing radiation aperture.
[0098] On the other hand, it is incorporated by the electron device which the light which carried out incidence from the wide angle was absorbed by the PN junction from the optical entrance window, and approached as an electrical signal by applying a reverse bias between a cathode 1504 and an anode 1505, in making it operate as a photo detector.
[0099] Since it has the spherical-surface configuration also in the light-receiving device, the case of a luminescence device is also a large include angle, and as for the front face, it has been the description with big outgoing radiation and incidence being possible.
[0100] In addition, the ball IC of this example can carry out simultaneous production not only of the optical I/O section but other ICs. It is indicated [approach / of IC / production] by JP,10-294254,A (U.S. Pat. No. 6097472 official report) "a spherical device aligner and the manufacture approach" etc. about the exposure approach etc.
[0101] In this example, the 3.3V actuation pre amplifier of a CMOS configuration was used as an object for photo detectors.
[0102] Next, the mounting approach of this spherical light device is explained using 12 from drawing 10 .
[0103] First, the hole of the shape of a possible semi-sphere of inserting said ball IC in said optical sheet substrate is made. The method of opening is arbitrary and good. You may form in the location beforehand regular using a photolithography and etching, and a hole may be formed in the location of arbitration according to an individual using laser etc. The heat dissolution process was used in this example.
[0104] This was heated by having used the ball of metal as metal mold 2000 like drawing 10 , it pressed against the above-mentioned resin substrate 1207 (drawing 11), and the semi-sphere-like impression 2100 was produced (drawing 12). The depth was carried out until it reached near the core layer of an optical wiring substrate. Of course, extent in which a hole reaches the core layer bottom may be hollowed.
[0105] As shown in drawing 4 , after printing electric wiring 1104 on an optical sheet after the process concerned, the electron device represented by LSI is mounted. Although this mounting approach could

be arbitrary, the flip chip mounting method was used here.
[0106] Next, it mounts so that the optical I/O section may become the impression of an optical sheet at the bottom of an impression. Alignment is carried out and it fixes so that optical ejection and optical incorporation may be possible and the optical I/O section may touch the bottom of an impression (refer to drawing 13). Since it is the spherical surface in the case of this example, a fine alignment precision is not needed. After performing alignment of an impression 2100 and a spherical device, it fixed with ultraviolet-rays hardening resin etc.
[0107] The electron device which carried out the surface mount to the spherical light I/O device is connected with the last by print electric wiring. To this, a bump or plating is desirable. Drawing 13 is a bump 2302 and shows the example which connected the printed circuit 1104 and the electrode 1504.
[0108] In addition, although E/O and the example using spherical IC as an O/E converter were shown, it is not limited to this.
[0109] (Principle of operation) The principle of operation is explained below.
[0110] First, a transmitting function is explained.
[0111] Drawing 4 is the enlarged drawing of the A section of drawing 3 . In drawing 4 , the output electrical signal (CMOS logic) of the I/O section of LSI1103 can transmit a signal to a nearby electron device through electric wiring 1104.
[0112] However, it is also possible to carry out the direct drive of the optical I/O device (for example, spherical light device) which approached, to generate the output lightwave signal 1211, and to use as optical wiring through the optical waveguide layer (optical sheet) 1206. One of approaches can also be chosen if needed.
[0113] The case where the spherical light device which approached is driven is considered.
[0114] The logic signal (for example, if it is CMOS 3.3 V) of LSI is sufficient electrical potential difference to drive said spherical light device. An electrical signal is changed into a lightwave signal by impressing a logic signal so that it may become a spherical light device with forward bias.
[0115] Since light is emitted to the whole spherical surface at this time, diffusion propagation is carried out without special optical system all over the optical sheet. Consequently, the joint effectiveness to waveguide can secure 80% or more.
[0116] Next, a reception function is explained.
[0117] If the input lightwave signal 1210 spread from the direction of the arbitration of the optical sheet 1206 arrives at the front face of the spherical photo detector 1201, it will be incorporated inside, it is absorbed near the PN junction to which the reverse bias was applied, and is changed into an electronic signal.
[0118] The changed electrical signal is incorporated and processed to the LSI1103 interior which approaches as an input electrical signal 1203. under the present circumstances -- if the pre amplifier which amplifies an electrical signal is accumulated on the spherical light device front face -- CMOS -- it can restore to a compatible electrical potential difference.
[0119] If this invention is used as mentioned above, while being able to reduce the direction dependency of a light sensing portion.
[0120] In addition, when two or more metal wiring approaches mutually, and is arranged and high-speed data transmission (for example, 1Gbps) is performed, the strength of the electromagnetic radiation noise of the near is expressed with "strength of source of release" (frequency, wave, actuation current) x"transfer constant (resonance-with power-source line, association with approaching line)" x "an antenna factor (a connector, electrode)."
[0121] That is, a noise level becomes high, so that a signal pulse is so close to a square wave that the speed of a signal is so quick that a current value is so large that a wire length is long.
[0122] Therefore, when using metal wiring near [CPU for which high-speed processing is needed], EMI cannot be removed fundamentally.
[0123] It is possible to improve these by on the other hand using light for wiring like this example. It is because there is no electromagnetic induction, so a transfer constant becomes zero in optical wiring.
[0124] Like this example, by separating into two-layer, and arranging an electric wiring layer and an

optical transmission layer, and making this optical transmission layer into two-dimensional optical waveguide (optical sheet), the effect of EMI by the specific device can be prevented, and a production process can also especially offer an easy photoelectrical fusion wiring substrate.
[0125] The physical magnitude which wiring of per one of optical wiring takes on the other hand is large single or more figures compared with electric wiring, when using optical waveguide (the so-called single dimension type of waveguide). So, size becomes large or, as for changing all electric wiring into optical wiring, the direction of a demerit, like loss by bending becomes large becomes large.
[0126] Furthermore, there is also a demerit which is obliged to modification of the conventional electric circuit pattern by introducing optical wiring.
[0127] At this example, the two above-mentioned demerits are improved by making this optical transmission layer into two-dimensional optical waveguide (optical sheet). The degree of freedom of arrangement is raised by applying two-dimensional waveguide (sheet-like optical waveguide) to the optical waveguide used as optical wiring. Moreover, in transmitting light to an optical sheet from a light-emitting part, although optical data are transmitted in all the directions two-dimensional from the luminescence device concerned, it can do.
[0128] In addition, it is desirable that light can be emitted to the omnidirection of 2D and the light from the omnidirection of 2D can be received as a light-receiving device as a luminescence device connectable with two-dimensional optical waveguide. The device concerned is an optical device produced for example, on the spherical surface.
[0129] When the front face of a photo detector is made spherical, a device design can be carried out so that the light from all bearing can be received. This appears as a relaxation effect with a large mounting precision, in case propagation incorporates the light of the waveguide of immobilization.
[0130] It can be made to operate as an optical I/O component by this spherical device independent by a bias circuit making an amplifying circuit to a spherical optical device. This lessens effect which it has on the design of the conventional electronic circuitry, and can realize optical INTAKONEKUTO.
[0131] (Example 4: Clock distribution) The application of this invention is explained below.
[0132] In drawing 3 , two or more electronic parts (CPU, memory, etc.) 1103 are mounted on one substrate 1101, and the case where a part of the wiring has combined with the substrate with the spherical light device 1201 like an example 3 is considered.
[0133] drawing 3 -- it is and let LSI1106 be a clock generator.
[0134] At this time, a signal is sent for a clock signal to the optical waveguide section of a photoelectrical fusion substrate through the spherical light device 1208 (drawing 4). The signal which had optical wiring chosen is outputted to a spherical light device, and this is driven by the signal itself sent with CMOS. A driver does not need specially. Therefore, the semiconductor laser of the GaAsN system which operates by the low battery as an optical device is used.
[0135] The spherical light device 1208 changes a clock signal into light, and distributes the clock signal which turned into a lightwave signal at all the devices on a substrate. Since the electron device (for example, MPU1103) of the arbitration on a substrate also has the spherical light device 1201, it receives the lightwave signal from a clock generator 1106. Since the spherical light device 1201 has the spherical-surface configuration, it can receive the light from the direction of arbitration at high light-receiving effectiveness.
[0136] The light which received light is divided into an electron and a hole pair, and by the pre amplifier produced by a spherical light device top or approaching LSI, an electrical signal is amplified and it is incorporated by MPU. Since other devices (for example, RAM) can receive a clock signal by the same approach, it can be made to operate with a common clock.
[0137] according to [although effect of EMI by wiring delay or high-speed high current actuation was not able to be conventionally disregarded since a circuit pattern was not able to be chosen freely, or since wiring distance was not made to isometry when it was going to distribute the clock signal to each device] this example -- optical wiring -- using -- the minimum distance -- and electromagnetism -- since it can wire by no guiding, these troubles are solvable at once.
[0138] (Example 5:MPU -> memory (serial transmission)) Other applications are explained below.

[0139] Drawing 14 is a mimetic diagram for explaining the example of this invention. In drawing, 2407 and 2408 are two CPUs. 2409 is RAM which these two CPUs share. In this drawing, the electric wiring for parallel transmission in 2401 and 2402 are optical wiring for serial transmissions.
[0140] In the usual electric wiring, the data line 2401 of 64-bit width of face is needed in six transmission lines, for example.
[0141] For the application sent at a mass data high speed, data may be unable to be correctly sent for the reason (wiring delay and EMI) explained previously in the conventional wiring (animation etc.). In such a case, optical wiring can be used. Specifically, the optical wiring 2402 is used for all or a part of exchanges of a signal between CPU and RAM.
[0142] Moreover, in drawing 14 , the case where 2400 is MPU and 2407 and 2408 are memory is considered. In order to send data to memory by 64-bit width of face from MPU, as electric wiring, six are required, but parallel serial conversion is carried out in the last stage of MPU, and after being connecting one optical I/O component, transmitting an electrical signal in the optical waveguide section of a photoelectrical fusion substrate as a lightwave signal and receiving light with the optical I/O component by the side of a receptacle, it is carrying out serial parallel conversion, and considers as the parallel signal of 64-bit width of face. Although a clock becomes high by carrying out serial conversion from parallel, in order to spread to optical waveguide, there are no worries about EMI.
[0143] Although optical wiring is chosen from the beginning in this example, it is not necessary to necessarily use only optical wiring. That is, it is possible to connect as optical wiring by enabling it to also choose the pass of electric wiring at electric wiring and a certain time at a certain time. This flexibility is one of the features of this invention.
[0144] In electric wiring, since EMI is avoided, it may wire so that other devices may be avoided, and as a result, a wire length may become long, and it may become the cause of wiring delay or waveform distortion shortly. Since connection of an EMI free-lancer can be performed by the shortest by choosing optical wiring at this time, wiring delay does not produce waveform distortion, either.
[0145] As for which signal is made electric wiring or optical wiring, the device which manages a bus determines the last decision.
[0146] The light changed into light diffuses and spreads the inside of the optical waveguide of 2D, and reaches to IC arranged in the other place. The ball IC for O/E conversion is installed also near [this] the IC. This example installed the same ball IC. Since direct light hits a pn junction side even if it uses neither prism nor a mirror, since the front face is carrying out the shape of a globular form, it can mount very simple.
[0147] (Example 6: Accumulate pin-PD and amplifier on Ball Si) Drawing 15 is a mimetic diagram for explaining the example concerning this invention.
[0148] In drawing, 2508 is a spherical Si substrate, the Northern Hemisphere section shows a front face, and the Southern Hemisphere section shows the sectional view. The photo detector by which 2509 was formed in the Southern Hemisphere section, and 2503 are ICs, such as pre amplifier which amplifies the bias circuit which drives it, and an electrical signal. 2510 [in addition,] -- an optical waveguide substrate and 2506 -- for an electrode and 2512, as for a bump and 2511, a printed circuit and 2504 are [a core layer and 2505 / a cladding layer and 2506 / output light and 2507] input light.
[0149] Hereafter, the manufacture approach of the semiconductor device shown in drawing 15 is explained.
[0150] first, drawing 16 -- like -- the undoping spherical Si substrate 2601 (diameter about 1mmphi) -- mostly, in one half (Southern Hemisphere section), by the ion implantation, the p-Si layer 2521, the i-Si layer 2509, and the n-Si layer 2520 are formed, and it considers as a photo detector field. The depth is 0.3um extent, respectively. Annealing treatment performs crystal recovery if needed.
[0151] Next, as shown in drawing 17 (an upper half expresses a ball front face and the lower half expresses the ball cross section), the bias circuit 2701 for applying a reverse bias to this photo detector to the remaining ball surface fields (Northern Hemisphere section), the pre amplifier circuit 2702 amplified to the voltage level of a request of the electrical signal changed from the lightwave signal, and waveform shaping circuit 2703 grade are produced. In addition, as for electric wiring and 2705, 2704 is

[a photo detector electrode and 2506] electronic-circuitry electrodes. Since it is an electrode for an electrode 2705 to impress 2521 to the n-Si layer 2520, and for 2706 impress an electrode to a p-Si layer, respectively, the potential of an electrode 2705 is made not to be impressed to the n-Si layer 2520.

[0152] Here, all electronic circuitries are 3.3V. A CMOS logical circuit is used. Simultaneously, the positive electrode 2705, the negative electrode 2706, and the circuit pattern 2704 of a photo detector are formed. Moreover, 2506 is an external electrode for electronic-circuitry I/O.

[0153] An example of the mounting approach is shown below. In drawing 15 , 2510 is the cladding layer which served as the substrate made in PMMA, and the core layer (it has become sheet-like) from which 2506 becomes optical waveguide, and 2505 are cladding layers. A core layer 2506 and a cladding layer 2505 apply photosensitive polyimide etc., and the spherical photoelectrical fusion device of this invention produces the hollow which can be inserted in with a HOTORISO technique etc. After printing a desired circuit pattern on besides, the photoelectrical fusion device of this invention is fixed with ultraviolet-rays hardening resin (not shown).

[0154] Then, as shown in drawing 18 , contact to a circuit pattern 2803 and the electrode 2506 on a device is taken using Au bump 2804 grade. Plating may be used for this process instead of a bump.

[0155] The principle of operation is explained below.

[0156] In drawing 15 or drawing 17 , a reverse bias (for example, 3.3V) is applied to the pn junction of a photoelectrical fusion device by the bias circuit 2701. At this time, this photoelectrical fusion device can receive the lightwave signal which spreads the inside of the two-dimensional optical core layer 2506 from the direction of arbitration. This is because a part of light sensing portion [at least] is embedded at the optical transmission medium.

[0157] An input lightwave signal is incorporated inside, is absorbed near the PN junction to which the reverse bias was applied, and is changed into an electronic signal. After the changed electrical signal was amplified to the CMOS logic level by the pre amplifier 2702 which approaches as an input electrical signal and it is further processed in the 2701 grades of waveform shaping circuit drawing 17 , it is transmitted to the printed circuit contacted by the bump.

[0158] As mentioned above, according to the explained example, the light from the direction of (1) two-dimensional arbitration is receivable, magnification and waveform shaping can be performed and (3) mounting becomes easy in the electronic circuitry by which (2) accumulation was carried out. furthermore, the effect which it has on the electronic circuitry of (4) existing -- it can lessen and can consider as I/O of optical INTAKONEKUTO with one device.

[0159] (example 7:III-VN on Ball GaAs) This example uses a spherical GaAs substrate instead of a spherical Si substrate.

[0160] The manufacture approach is explained using drawing 19 .

[0161] From the front face of the high grade undoping spherical GaAs substrate 2901, a 2902p mold GaAs layer, a 2903GaAsN optical absorption layer, and a 2904n mold GaAs layer are formed by the ion implantation.

[0162] The high impurity concentration of 1E19cm-3 and n mold of the high impurity concentration of p mold is about [one E18cm -] three (an ion kind can be set to arbitration). Undoping GaAsN consists of carrying out the ion implantation (for example, 1E21cm-3) of the N to high concentration to GaAs. RTA (Rapid Thermal Annealing) is effective in order to remove the damage at the time of an ion implantation.

[0163] The impregnation depth set up the ion-implantation conditions of other layers so that a GaAsN layer might serve as thickness 0.2um.

[0164] A next process and a next mounting process apply to an example 6.

[0165] The electronic-circuitry section can produce the electronic circuitry which has an example 6 and a function more than equivalent by carrying out in a Bipola process. Not perfect aperture structure but mesh structure is sufficient as an electrode.

[0166] Hereafter, it explains focusing on a different point from an example 6.

[0167] When making it operate as a light-receiving device, it is the same as the case of an example 6. That is, it is incorporated by the electron device which the light which carried out incidence from the

wide angle was absorbed by the PN junction from the optical entrance window, and approached as an electrical signal by applying a reverse bias to the p-GaAs layer 2902 and the n-GaAs layer 2904 in drawing 19 , respectively. Since the band gap is smaller than GaAs, GaAsN operates by the low battery rather than GaAs.
[0168] Furthermore, since mobility is larger than Si, a high-speed response is possible. In addition, 2903 is an i-GaAsN layer.
[0169] Since GaAsN is the compound semiconductor of a direct transition mold, it is usable also as a light emitting device. When making it operate as a light emitting device, in drawing 15 or drawing 17 , the light which emitted light by the PN junction is emitted to a wide angle from an optical outgoing radiation aperture by applying forward bias to electrodes 2705 and 2706. You may drive by the logic data itself and may drive through a driver circuit.
[0170] Since it has the spherical-surface configuration also in the light-receiving device, the case of a luminescence device is also a large include angle, and as for the front face, it has been the description with big outgoing radiation and incidence being possible.
[0171] (example 8: GaAsN films - facets of Ball Si)
Drawing 20 is a mimetic diagram for explaining this example.
[0172] This example carries out the laminating of GaAsN/AlGaAsN to a ball Si substrate, and is taken as a light emitting device or a photo detector. 3101 -- a spherical semi-conductor substrate and 3102 -- IC and 3103 -- an optical device and 3104 -- for a core layer and 3107, as for a printed circuit and 3109, a cladding layer and 3108 are [a bump and 3105 / an optical waveguide substrate and 3106 / output light and 3110] input light.
[0173] Hereafter, the manufacture approach is explained.
[0174] (Production of Ball IC) Like drawing 21 , IC3102 is produced on the semi-sphere front face (here Northern Hemisphere front face) of the undoping spherical Si substrate (1mmphi) 3101. In the case of a light emitting device, this IC is Actuation IC or is a parallel serial conversion circuit. In the case of a photo detector, they are a bias circuit, pre amplifier, a wave equalization circuit, or a serial parallel conversion circuit. When serving as both functions, of course, the electronic circuitry according to it is added. Being able to produce these circuits by the usual CMOS process, the logic electrical potential difference is 3.3V. 3111 is electric wiring.
[0175] (Production of an optical device) An optical device is produced after an Si ball IC process is completed mostly.
[0176] first, the ball whole -- a nitride (SiN) etc. -- covering -- an optical device production part -- a flat surface -- polish -- and polishing is carried out. In a nitride, that of a wrap is for using it as a mask for selective growth in order to protect an electron device in an optical device process. It is desirable to form the film with small stress for the spherical surface for a wrap reason (here, Si3N4 (200nm in thickness) was used).
[0177] As an optical device production field, the field (100) (it is the 4th page at (010), (-100), and all (0-10)) 3301 according to the field and it in the Southern Hemisphere (111) was used by this example (triangular one-side about 20-micrometer flat surface). Drawing 22 is the top view which looked at drawing 21 from the south pole, 3101 is a spherical substrate and 3301 is a considerable (111) side.
[0178] Drawing 23 is the sectional view of this one field. An aperture is opened only in a device production field after covering the whole by a nitride etc. again, if required. Since selective growth was carried out according to the configuration of opening, opening was controlled by this example to become cylinder-like. As for a spherical semi-conductor substrate and 3301, 3101 is [a field (111) and 3401] SiN films.
[0179] The reason for having chosen the considerable (111) side here is as follows.
(1) Since it is chemically equivalent, uniform structure is producible with the crystal growth performed to a degree. (When it includes other crystal faces, an anisotropy arises in a presentation, thickness, and the crystal growth direction.)
(2) The field which touches the south pole (it is because the light from bleedoff or at least 4 directions can be received for light in at least four directions to the propagation of light.) If it has a function more

than the above and an EQC, it will not restrict to a considerable (111) side.
[0180] (Crystal growth) Device structure is explained using drawing 24 . the gas source MBE (molecular beam epitaxy) -- law or MOCVD (organic metal vacuum evaporationo) -- it carries out a laminating only to a selection field (opening) first using law, using GaNxAs 1-x as a buffer layer 3501. What is necessary is just to choose the lattice constant at this time suitably according to the conditions of a cladding layer and a barrier layer.
[0181] Here, after changing the nitrogen presentation X gradually from 0.2 to 0 so that lattice matching may be carried out to In0.1Ga0.9As, the laminating of the InGaAs was carried out further, changing the presentation of In gradually. Then, the laminating of the n-InAlGaAs cladding layer 3502, the GaInNAs/InAlGaAsMQW (multiplex quantum well) barrier layer (luminescence wavelength 1.3um) 3503, the p-InAlGaAs cladding layer 3504, and the p-InGaAs contact layer 3505 is carried out one by one. After attaching the aperture 3507 for optical ON outgoing radiation, a positive electrode 3506 is formed. The negative electrode is succeedingly formed in a desired location from the interior of a ball, an unnecessary nitride is removed, it wires with the electrode of IC, and this example is completed. 3101 is a spherical semi-conductor substrate and 3401 is a selection mask.
[0182] (Mounting) The example of mounting is shown in drawing 25 . In drawing, 3601 is substrates, such as PMMA, and 3602 is an optical waveguide core layer which consists of polyimide formed on it. The cladding layer 3603 which applied to PMMA correspondingly on it is formed. The hollow which can insert the above-mentioned spherical photoelectrical fusion device in this cladding layer 3603 and core layer 3602 is formed by FOTORISO etc. This device is fixed with ultraviolet-rays hardening resin etc. after it (not shown). Then, a printed circuit 3501 and contact are taken using the Au bump 3502.
[0183] (Principle of operation) The principle of operation is explained below.
[0184] (in the case of a light emitting device) In drawing 20 or drawing 21 , a light emitting device 3103 emits a lightwave signal with the electrical signal supplied from a driver IC 3102. This lightwave signal is emitted to the mounted core layer as an output light. Since direct optical coupling is carried out to the core layer, light can be efficiently led to optical waveguide.
[0185] What is necessary is to modulate the same signal simultaneously and just to take out a lightwave signal to send out a lightwave signal to a two-dimensional omnidirection. In a current case, it is 4 bearing, but since this light emitting device is LED, since directivity is weak, it is uniformly spread by near intensity distribution to a real omnidirection. What is necessary is just to produce a light emitting device in the field bearings other than the phase (111) present which are a high order number more to make it still more uniform intensity distribution. Synchrotron orbital radiation is spreading two-dimensional optical waveguide after that, and tells the lightwave signal to other photoelectrical fusion devices.
[0186] The field copies-bound-together-in-one-volume example of a (photo detector) can be used also as a photo detector.
[0187] In drawing 20 or drawing 22 , a reverse bias (for example, 3.3V) is applied to the pn junction of a photoelectrical fusion device by the bias circuit 3301. At this time, this photoelectrical fusion device can receive the lightwave signal which spreads the inside of the two-dimensional optical core layer 3106 from the direction of arbitration. This is because the light-receiving side has the spherical-surface configuration. An input lightwave signal is incorporated inside, is absorbed near the PN junction to which the reverse bias was applied, and is changed into an electronic signal. After the changed electrical signal was amplified to the CMOS logic level by the pre amplifier 3102 which approaches as an input electrical signal (or attenuation) and it is further processed in waveform shaping circuit 3102 grade, it is transmitted to the printed circuit contacted by the bump.
[0188] (Effectiveness) The effectiveness of this example is as follows.
(1) Thing (3) mounting which can be amplified and shaped in waveform in the electronic circuitry which can receive the light from the direction of two-dimensional arbitration, and by which thing (2) accumulation was carried out can lessen effect which it has on the easy electronic circuitry of thing (4) existing, and can consider as I/O of optical INTAKONEKUTO with one device. ((GaAs) Example 9:III-VNon ball)

This example uses a spherical GaAs substrate instead of a spherical Si substrate. In order to carry out lattice matching of the GaInNAs to GaAs, it has the features which can carry out band gap control simply rather than the case where Si substrate is used.
[0189] The manufacture approach is explained using drawing 24 .
[0190] (Production of Ball IC) IC3102 is produced like drawing 21 , the part (here Northern Hemisphere front face), for example, the semi-sphere surface section, of the undoping spherical Si substrate (1mmphi) 3101. In the case of a light emitting device, this IC is Actuation IC or is a parallel serial conversion circuit. In the case of a photo detector, they are a bias circuit, pre amplifier, a wave equalization circuit, or a serial parallel conversion circuit. When serving as both functions, of course, the electronic circuitry according to it is added.
[0191] These circuits are producible in usual FET or a usual Bipolar process. the inside of drawing 24 , and 3101 -- for a cladding layer and 3505, as for an electrode and 3507, a contact layer and 3506 are [a spherical semi-conductor substrate and 3501 / a buffer layer and 3502 / an aperture and 3401] selection masks.
[0192] (Production of an optical device) An optical device is produced after a GaAs ball IC process is completed mostly.
[0193] first, the ball whole -- a nitride etc. -- covering -- an optical device production part -- a flat surface -- polish -- and polishing is carried out. In a nitride, that of a wrap is for using it as a mask for selective growth in order to protect the electron device in an optical device process. It is desirable to form the film with small stress for the spherical surface for a wrap reason. As an optical device production field, the field (100) (it is the 4th page at (010), (-100), and all (0-10)) 3301 according to the field and it in the Southern Hemisphere (111) was used by this example (triangular flat surface of one-side about 20 um extent). Drawing 14 is the top view which looked at drawing 21 from the south pole. Drawing 23 is the sectional view of this one field. An aperture is opened only in a device production field after covering the whole by a nitride etc. again, if required. Since selective growth was carried out according to the configuration of opening, opening was controlled by this example to become cylinder-like.
[0194] The reason for having chosen the considerable (111) side here is as follows.
(1) Since it is chemically equivalent, uniform structure is producible with the crystal growth performed to a degree. (When it includes other crystal faces, an anisotropy arises in a presentation, thickness, and the crystal growth direction.)
(2) The field which touches the south pole (it is because the light from bleedoff or at least 4 directions can be received for light in at least four directions to the propagation of light.) If it has a function more than the above and an EQC, it will not restrict to a considerable (111) side.
[0195] (Crystal growth) Device structure is explained using drawing 24 . the gas source MBE (molecular beam epitaxy) -- law or MOCVD (organic metal vacuum evaporationo) -- it carries out a laminating only to a selection field (opening) first using law, using GaAs as a buffer layer 3501. Next, the laminating of the InGaAs was carried out further, changing the presentation of In gradually for example, so that lattice matching may be carried out to In0.1Ga0.9As. Then, the laminating of the n-InAlGaAs cladding layer 3502, the GaInNAs/InAlGaAsMQW (multiplex quantum well) barrier layer (luminescence wavelength 1.3um) 3503, the p-InAlGaAs cladding layer 3504, and the p-InGaAs contact layer 3505 is carried out one by one. Since the process of this crystal growth is III-V groups' laminating, it has the features of being easier than the III-V group formation on Si of an example 8. Next, after attaching the aperture 3507 for optical ON outgoing radiation, a positive electrode 3506 is formed. The negative electrode is succeedingly formed in a desired location from the interior of a ball, an unnecessary nitride is removed, it wires with the electrode of IC, and this example is completed.
[0196] (Mounting) The example of mounting is shown in drawing 25 . In drawing, 3601 is substrates, such as PMMA, and 3602 is an optical waveguide core layer which consists of polyimide formed on it. The cladding layer 3603 which applied to PMMA correspondingly on it is formed. The hollow which can insert the above-mentioned spherical photoelectrical fusion device in this cladding layer 3603 and core layer 3602 is formed by FOTORISO etc. This device is fixed with ultraviolet-rays hardening resin

etc. after it (not shown). Then, it is with the Au bump 3502 and a printed circuit 3501 and contact are taken.
[0197] (Principle of operation) When making it operate as a light-receiving device, it is the same as the case of the above-mentioned example. That is, it is incorporated by applying a reverse bias to an optical device by the electron device which the light which carried out incidence from the wide angle was absorbed by the PN junction from the optical entrance window, and approached as an electrical signal. Ga (In) Since the band gap is smaller than GaAs, NAs operates by the low battery rather than GaAs. Furthermore, since mobility is larger than Si, a high-speed response is possible.
[0198] Since GaInNAs is the compound semiconductor of a direct transition mold, it is usable also as a light emitting device. When making it operate as a light emitting device, in drawing 20 or drawing 22 , the light which emitted light by the PN junction is emitted to a wide angle from an optical outgoing radiation aperture by applying forward bias to the actuation electrode of a light emitting device. You may drive by the logic data itself and may drive through a driver circuit.
[0199] Since it has the spherical-surface configuration also in the light-receiving device, the case of a luminescence device is also a large include angle, and as for the front face, it has been the description with big outgoing radiation and incidence being possible.
[0200] (Effectiveness) Effectiveness peculiar to this invention is as follows.
(1) Compared with GaAs, light can be received more for the light of long wavelength. In the case of 0.85um bands, the light source may be insufficient for light-receiving sensibility by Si-pinPD of an example 1, but the worries do not exist at this example. The burden of this of an electrical circuit also decreases.
(2) CMOS is FET and GaAs to instead of, although it cannot use. Since a bipolar circuit can be used, it is advantageous to high-speed processing.
(3) High-speed processing can be carried out, and thing utilization can be carried out, and parallel data can be changed into serial data and can be transmitted.
(4) Since GaAsN is a direct transition mold with this structure, it is usable also as a light emitting device.
[0201] In this example, although the spherical GaAs substrate was used, it does not restrict to this.
[0202] (Example 10:III-VN on spherical InP substrate) Other effectiveness can be acquired by using a spherical InP substrate for a substrate. It explains using drawing 24 again.
[0203] (Production of Ball IC) Like drawing 21 , IC3102 is produced on the semi-sphere front face (here Northern Hemisphere front face) of the undoping spherical InPi substrate (1mmphi) 3101. In the case of a light emitting device, this IC is Actuation IC or is a parallel serial conversion circuit. In the case of a photo detector, they are a bias circuit, pre amplifier, a wave equalization circuit, or a serial parallel conversion circuit. When serving as both functions, of course, the electronic circuitry according to it is added. These circuits are producible in usual FET or a usual Bipolar process. Compared with GaAs, since a band gap is small and mobility is large, a high-speed driver circuit can be used.
[0204] (Production of an optical device) An optical device is produced after an InP ball IC process is completed mostly.
[0205] first, the ball whole -- a nitride etc. -- covering -- an optical device production part -- a flat surface -- polish -- and polishing is carried out. In a nitride, that of a wrap is for using it as a mask for selective growth in order to protect the electron device in an optical device process. It is desirable to form the film with small stress for the spherical surface for a wrap reason. As an optical device production field, the field (100) (it is the 4th page at (010), (-100), and all (0-10)) 3301 according to the field and it in the Southern Hemisphere (111) was used by this example (triangular flat surface of one-side about 20 um extent). Drawing 22 is the top view which looked at drawing 21 from the south pole. Drawing 23 is the sectional view of this one field. An aperture is opened only in a device production field after covering the whole by a nitride etc. again, if required. Since selective growth was carried out according to the configuration of opening, opening was controlled by this example to become cylinder-like.
[0206] The reason for having chosen the considerable (111) side here is as follows.

(1) Since it is chemically equivalent, uniform structure is producible with the crystal growth performed to a degree. (When it includes other crystal faces, an anisotropy arises in a presentation, thickness, and the crystal growth direction.)
(2) The field which touches the south pole (it is because the light from bleedoff or at least 4 directions can be received for light in at least four directions to the propagation of light.) If it has a function more than the above and an EQC, it will not restrict to a considerable (111) side.
[0207] (Crystal growth) Device structure is explained using drawing 24 . the gas source MBE (molecular beam epitaxy) -- law or MOCVD (organic metal vacuum evaporationo) -- it carries out a laminating only to a selection field (opening) first using law, using InP as a buffer layer 3501. Next, the laminating of the InGaP was carried out further, changing the presentation of In gradually for example, so that lattice matching may be carried out to In0.9Ga0.1P. Then, the laminating of the n-InAlGaP cladding layer 3502, the GaInNP/InAlGaPMQW (multiplex quantum well) barrier layer (luminescence wavelength 1.5um) 3503, the p-InAlGaP cladding layer 3504, and the p-InGaP contact layer 3505 is carried out one by one. After attaching the aperture 3507 for optical ON outgoing radiation, a positive electrode 3506 is formed. The negative electrode is succeedingly formed in a desired location from the interior of a ball, an unnecessary nitride is removed, it wires with the electrode of IC, and this example is completed.
[0208] (Mounting) The example of mounting is shown in drawing 25 . In drawing, 3601 is substrates, such as PMMA, and 3602 is an optical waveguide core layer which consists of polyimide formed on it. The cladding layer 3603 which applied to PMMA correspondingly on it is formed. The hollow which can insert the above-mentioned spherical photoelectrical fusion device in this cladding layer 3603 and core layer 3602 is formed by FOTORISO etc. This device is fixed with ultraviolet-rays hardening resin etc. after it (not shown). Then, a printed circuit 3605 and contact are taken using the Au bump 3606.
[0209] (Principle of operation) When making it operate as a light-receiving device, it is incorporated by applying a reverse bias to an optical device by the electron device which the light which carried out incidence from the wide angle was absorbed by the PN junction from the optical entrance window, and approached as an electrical signal. Since the band gap is smaller than InP, InGaPN operates by the low battery rather than InP. Since mobility is still larger than GaAs, a high-speed response is possible.
[0210] Since InGaPN is the compound semiconductor of a direct transition mold, it is usable as a light emitting device. When making it operate as a light emitting device, in drawing 12 or drawing 14 , the light which emitted light by the PN junction is emitted to a wide angle from an optical outgoing radiation aperture by applying forward bias to an optical device. You may drive by the logic data itself and may drive through a driver circuit.
[0211] Since it has the spherical-surface configuration also in the light-receiving device, the case of a luminescence device is also a large include angle, and as for the front face, it has been the description with big outgoing radiation and incidence being possible.
[0212] (Effectiveness) Effectiveness peculiar to this invention is as follows.
(1) Since the band gap is small, the burden to an electrical circuit is small.
(2) Compared with Si or GaAs, a still more nearly high-speed circuit is producible.
(3) Since the light of 1.5um bands can be used, it can couple directly without a junction circuit also with a low loss fiber, and long-distance high-speed transmission becomes possible.
[0213] (Example 11:III-VN on GaN substrate) Other effectiveness can be acquired by using a spherical GaN substrate for a substrate.
[0214] It explains [use / again / else / drawing 24].
[0215] (Production of Ball IC) Like drawing 21 , IC3102 is produced on the semi-sphere front face (here Northern Hemisphere front face) of the undoping spherical GaN substrate (1mmphi) 3101. In the case of a light emitting device, this IC is Actuation IC or is a parallel serial conversion circuit. In the case of a photo detector, they are a bias circuit, pre amplifier, a wave equalization circuit, or a serial parallel conversion circuit. When serving as both functions, of course, the electronic circuitry according to it is added. These circuits Usual FET or a usual Bipolar process (For example) S. C. Binari K. Doverspike G.Kelner H. B. Dietrich and A.E. Wickenden; Solid State Electronics 41 (1997), p.97 or S. Yoshida and

J. Suzuki ; Journal of Applied Physics Letters 85 (1999), It is producible by combining p.7931 etc. and a spherical Si process (example 8 reference). Compared with Si, since the band gap is very large, it has a performance index different from Si and other III-V ingredients that an elevated temperature, high pressure-proofing, and high frequency operation are possible.
[0216] (Production of an optical device) An optical device is produced after a GaN ball IC process is completed mostly.
[0217] first, the ball whole -- nitrides (SiN etc.) -- covering -- an optical device production part -- a flat surface -- polish -- and polishing is carried out. In a nitride, that of a wrap is for using it as a mask for selective growth in order to protect the electron device in an optical device process. It is desirable to form the film with small stress for the spherical surface for a wrap reason. As an optical device production field, the field (100) (it is the 4th page at (010), (-100), and all (0-10)) 3301 according to the field and it in the Southern Hemisphere (111) was used by this example (triangular flat surface of one-side about 20 um extent). Drawing 22 is the top view which looked at drawing 21 from the south pole. Drawing 23 is the sectional view of this one field. An aperture is opened only in a device production field after covering the whole by a nitride etc. again, if required. Since selective growth was carried out according to the configuration of opening, opening was controlled by this example to become cylinder-like.
[0218] The reason for having chosen the considerable (111) side here is as follows.
(1) Since it is chemically equivalent, uniform structure is producible with the crystal growth performed to a degree. (When it includes other crystal faces, an anisotropy arises in a presentation, thickness, and the crystal growth direction.)
(2) The field which touches the south pole (it is because the light from bleedoff or at least 4 directions can be received for light in at least four directions to the propagation of light.) If it has a function more than the above and an EQC, it will not restrict to a considerable (111) side.
[0219] (Crystal growth) Device structure is explained using drawing 24 . the gas source MBE (molecular beam epitaxy) -- law or MOCVD (organic metal vacuum evaporationo) -- it carries out a laminating only to a selection field (opening) first using law, using GaN as a buffer layer 3501. Next, the laminating of the n-AlGaN cladding layer 3502, the GaInN/AlGaNMQW (multiplex quantum well) barrier layer (luminescence wavelength 0.4um) 3503, the p-AlGaN cladding layer 3504, and the p-GaN contact layer 3505 is carried out one by one. After attaching the aperture 3507 for optical ON outgoing radiation, a positive electrode 3506 is formed. The negative electrode is succeedingly formed in a desired location from the interior of a ball, an unnecessary nitride is removed, it wires with the electrode of IC, and this example is completed.
[0220] (Mounting) The example of mounting is shown in drawing 25 . In drawing, 3601 is substrates, such as PMMA, and 3602 is an optical waveguide core layer which consists of polyimide formed on it. The cladding layer 3603 which applied to PMMA correspondingly on it is formed. The hollow which can insert the above-mentioned spherical photoelectrical fusion device in this cladding layer 3603 and core layer 3602 is formed by FOTORISO etc. This device is fixed with ultraviolet-rays hardening resin etc. after it (not shown). Then, it is with the Au bump 3606 and a printed circuit 3605 and contact are taken.
[0221] (Principle of operation) When making it operate as a light-receiving device, it is completely the same as the case of an example 8.
[0222] That is, it is incorporated by applying a reverse bias to an optical device by the electron device which the light which carried out incidence from the wide angle was absorbed by the PN junction from the optical entrance window, and approached as an electrical signal. Although high tension is more nearly required for GaN than Si, GaAs, or InP since the band gap is far large, on the other hand, there is the advantage in which elevated-temperature actuation is possible [electron device and optical device].
[0223] When making it operate as a light emitting device, in drawing 20 or drawing 22 , the light which emitted light by the PN junction is emitted to a wide angle from an optical outgoing radiation aperture by applying forward bias to an optical device. You may drive by the logic data itself and may drive through a driver circuit.

[0224] Since it has the spherical-surface configuration also in the light-receiving device, the case of a luminescence device is also a large include angle, and as for the front face, it has been the description with big outgoing radiation and incidence being possible. The effectiveness in this example is as follows.
(1) Since the band gap is large, elevated-temperature actuation is possible.
(2) Compared with Si or GaAs, high proof-pressure actuation is possible.
(3) Since the light of 0.4um bands can be used, On/Off can be checked with the naked eye.
[0225] (Example 12: (IC) Monolayer electrical-and-electric-equipment wiring layer + light wiring layer + photograph nick ball) Drawing 26 is a mimetic diagram for explaining the example concerning this invention.
[0226] It is the optical wiring layer and the electric wiring layer by which 4101 was formed in the maintenance substrate and 4108 and 4107 were formed on it in drawing 26 . 4102 is IC chip mounted on the electric wiring layer 4102.
[0227] Drawing 27 is the enlarged drawing of the B section of drawing 1 , and it is the electrode pad to which a bump (for example, ball pewter) for 4103 to mount IC4102 and 4104 connect the photograph nick ball IC to, and 4105 connects them electrically. 4106 and 4109 are the two-dimensional optical waveguide layers (an optical film is called below) and cladding layers which constitute the optical wiring layer 4108. The above configuration is called a photoelectrical fusion substrate.
[0228] In this example, it faces connecting the IC chip 4102 to the electric wiring layer 4107, and two or more metal bumps are used (drawing 26). And some two or more metal bumps are changed to the photograph nick ball IC 4104 of it and comparable magnitude. Some photograph nick balls IC 4104 are embedded at the optical wiring layer 4108.
[0229] Although 0.5mm and a core layer 4106 were set to 0.1mm and the cladding layer 4109 set to 0.3mm the substrate 4111 which constitutes the optical wiring layer 4108, it does not restrict to this size. In addition, a cladding layer may exclude. The thermofusion nature resin material (0.3mm in thickness) which built in the Cu microstrip line 4110 of a monolayer as an electric wiring layer 4107 can be used.
[0230] ((IC) Photograph nick ball) One of the descriptions of this invention is in the point of performing mounting of IC chip to a photoelectrical fusion substrate through EO or OE device.
[0231] Next, the photograph nick ball IC which is an example of this EO or OE device is explained briefly (in addition, the manufacture approach is indicated by the publication-number No. 284635 [2001 to] official report, for example.).
[0232] In drawing 28 , it is the undoping spherical Si substrate (for example, 1mmphi) 4201, and 4202 is IC formed in the semi-sphere front face (here Northern Hemisphere front face). 4203 is optical devices, such as a light emitting device or a photo detector formed in the Southern Hemisphere section front face, (the surface emission-type laser of the GaInNAs/AlGaAs system formed in four considerable (111) sides here, and **** for two-dimensional photodiodes -- things are made).
[0233] When accumulated with a light emitting device 4203, IC4202 is Actuation IC or is a parallel serial conversion circuit. When accumulated with a photo detector 4203, they are a bias circuit, pre amplifier, a wave equalization circuit, or a serial parallel conversion circuit. When serving as both functions, of course, the electronic circuitry according to it is added. Being able to produce these circuits by the usual CMOS process, the logic electrical potential difference is 3.3V.
[0234] Drawing 29 shows another gestalt of the photograph nick ball IC. Although the electronic-circuitry section is not different from the above in drawing, optical device parts differ greatly. 4305 is the barrier layer formed in the shape of a semi-sphere, and in the case of a luminescence device, the carrier poured in from the electrode 4307 for optical devices recombines it, and it emits light. In the case of a light-receiving device, a reverse bias is applied to a barrier layer 4305, and the light which received light forms an electronic-hole pair in it. Without light emission or optical absorption preparing special optical system, it is efficient to carry out the shape of a globular form in both cases, and they can carry out EO(ing) or OE conversion.
[0235] (Mounting of the photograph nick IC to a photoelectrical fusion substrate) Next, the mounting approach of this spherical light device is explained. First, the hole of the shape of a possible semi-sphere

of inserting said photograph nick ball IC in the front face (in the case of this example electric wiring layer 4107) of a photoelectrical fusion substrate is made. how to make a hole is boiled and attached and is as stated above.
[0236] Next, it mounts so that optical I device section may become the impression of an optical sheet at the bottom of an impression. Alignment is carried out and it fixes so that optical ejection and optical incorporation may be possible and the optical I/O section may touch the bottom of an impression (refer to drawing 30). It is fixable with the after [alignment] ultraviolet-rays effectiveness resin etc.
[0237] Next, electrical installation is performed by the flip chip mounting method. In drawing 30 , 4103 is a bump and 4105 is an electrode pad. Electric contact can be obtained at once by cooling, after putting a bump on IC lateral electrode pad 4105, carrying out alignment of said photograph nick ball IC 4104 a substrate side and fusing a bump by the reflow.
[0238] Thus, a process not only becomes simple, but by mounting flip chip mounting and the photograph nick ball IC simultaneously, it can raise the mechanical strength of the photograph nick ball IC.
[0239] Here, although a bump imagines a rectangular thing and is written, she does not need to adhere to this. Finally, it can consider as a still more stable mounting condition by what (not shown) the clearance between IC chip and a photoelectrical fusion substrate is filled up with a refill etc. for. It is easy to be natural, even if it uses a ball pewter for a bump and being mounted like BGA (Ball Grid Array).
[0240] (Principle of operation) The principle of operation is explained below.
[0241] (Transmitting function) In drawing 30 , the electrode pad 4105 of LSI4102 can transmit or receive a signal in a nearby electron device through a bump 4104. The logic signal (for example, if it is CMOS 3.3 V) of LSI is sufficient electrical potential difference to carry out the direct drive of said spherical light device.
[0242] An electrical signal is changed into a lightwave signal by impressing a logic signal so that it may become a luminescence device on the photograph nick ball IC 4104 (for example, LED) with forward bias (what is necessary is to build a driver circuit and bias and to just be crowded on the photograph nick ball IC, to apply the case where power is required, and predetermined bias voltage). The light which emitted light is emitted to a core layer 4106, and carries out diffusion propagation without special optical system as an output light 4109 all over the optical sheet. Substrate size can obtain a reception input required for minimum reception sensitivity enough by about 1mW of optical outputs, if 30mm** extent and propagation loss are 0.3 or less dB/cm.
[0243] (Reception function) If the input lightwave signal 4110 conversely spread from the direction of the arbitration of the optical wiring layer (optical film) 4108 arrives at photo detector 4102 front face of the photograph nick ball IC, it will be incorporated inside, it is absorbed near the PN junction to which the reverse bias was applied, and is changed into an electronic signal. The changed electrical signal is incorporated and processed as an input electrical signal to the LSI4102 approaching interior.
[0244] (Electric parallel and optical serial transmission) Electric parallel and an optical serial transmission are explained using drawing 31 . In drawing 31 , 4601 is a photoelectrical fusion substrate and, in addition to this, as for a device and 4605, RAM between which CPU shares 4602 and 4608 and these two CPUs share 4603, and 4604 are [electric wiring and 4606] optical wiring.
[0245] In the usual electric wiring, the data line of 64-bit width of face is needed in six transmission lines, for example. Even if low-speed data processing does not break out, for the application sent at a mass data high speed, that it is easy to be influenced, it becomes, or it is easy to have effect of EMI, and a problem consists of actuation of other devices (animation etc.) arranged on a substrate. It is very difficult to send the always stabilized data in the conventional wiring. Optical wiring is used only for such an application.
[0246] For example, although six are required as electric wiring in drawing 31 in order to send data to RAM4603 by 64-bit width of face from CPU4602 By carrying out parallel serial conversion in the last stage of CPU, and connecting one optical I/O component After an electrical signal is transmitted in the optical waveguide section of a photoelectrical fusion substrate and receives light with the optical I/O component by the side of a receptacle as a lightwave signal, it considers as the parallel signal of 64-bit

width of face by carrying out serial parallel conversion. Although a clock becomes high by carrying out serial conversion from parallel, in order to spread to optical waveguide, there are no worries about EMI.
[0247] In addition, it can mount easily by using flip chip mounting and the BGA method as the mounting approach, without applying the mounting approach new for optical wiring. BGA (Ball Grid Array) -- law connects the electrode pad of IC, and the electrode pad of a substrate in the shape of an array with the pewter called a bump, and has the extremely excellent properties, such as improvement in the speed, low occupancy area, and reduction in resistance, compared with the conventional wirebonding.
[0248] The pitch of BGA and type ball pewter size are 1mm and 0.50mmphi extent, respectively. That is, if the above-mentioned phot nick ball IC is below 1mmphi, the process of the usual BGA can be used.
[0249] An electron device and an optical device are accumulated on a semi-conductor substrate (usually spherical Si substrate) with the spherical photograph nick ball IC, and OE/EO conversion can be carried out in this one. If what can carry out a direct drive on the electrical potential difference of the logic signal from photoelectrical fusion substrate-like LSI is used, a special addition circuit will not have the need. moreover -- since it has the shape of a globular form -- ** -- the optical film section of said photoelectrical fusion substrate can be made to carry out optical association without needing another optical system
[0250] (Example 13: Replace the sequence of an electric wiring layer and an optical wiring layer) Drawing 32 is a mimetic diagram for explaining the example of this invention. Differing from the example 12 is the point that the electric wiring layer consists of a multilayer and the optical wiring layer has composition by which a laminating is carried out on it.
[0251] In drawing 32 , 4107 is an electric wiring layer which consists of multilayer internal wiring 4110, and 4108 is an optical wiring layer (optical film) which consists of a core layer 4106 and a cladding layer 4109.
[0252] The electrode pad 4105 and the circuit pattern (not shown) are arranged in the outermost surface of an optical wiring layer, and it is combined by the beer hall 4111 in the electric wiring layer 4107. Although this beer hall pierces through an optical wiring layer and it is formed, since light is spread two-dimensional, effect is small unless beer is formed in high density.
[0253] Effectiveness peculiar to this example is not based on the thickness of an electric wiring layer, but is in the point that an optical wiring layer can be installed.
[0254] (Example 14: Put in two optical sheets into a multilayer PCB substrate.) Drawing 33 is a mimetic diagram for explaining an example besides this invention.
[0255] Differing from the example 12 is the point that not only an electric wiring layer but the optical film is formed in both sides.
[0256] In drawing 33 , 4101 is a maintenance substrate and the structure of an example 13 is formed in both sides of a maintenance substrate. Furthermore, double-sided electrical installation can be performed by forming the beer hall 4111 which penetrates the maintenance substrate 4101. Other processes are the same as an example 12 or an example 13.
[0257] When special, the maintenance substrate 101 may be removed [******].
[0258] Drawing 34 is a mimetic diagram explaining the example in this case.
[0259] The photoelectrical fusion substrate consists of 2 sets of optical wiring layers (4108), and one multilayer-interconnection layer (4107). It can consider as a photoelectrical fusion flexible substrate because it is with the ingredient which has flexibility in both a multilayer-interconnection layer and an optical wiring layer.
[0260] In the situation that wiring in a multilayer-interconnection layer approaches and it becomes impossible to disregard EMI as well as a component-side product being made greatly, the advantages of this configuration are optical wiring of an EMI free-lancer being performed using an optical film, and having removed the maintenance substrate, and are being able to make it a more flexible substrate. For example, it is also possible to bend the substrate itself 90 degrees and to mount it.
[0261]

[Effect of the Invention] As mentioned above, in case the light which spreads an optical transmission field (optical sheet) is received by this invention, the semiconductor device which reduced direction dependency can be offered.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the semiconductor device which the optical transmission medium and the photo detector which performs photo electric translation loaded together. Especially, this optical transmission medium is related with the photoelectrical fusion substrate which consists of two-dimensional mold optical waveguides. Moreover, this invention relates to the photoelectrical fusion wiring substrate which has an electric wiring layer and an optical transmission layer. Moreover, this invention relates to a spherical device.

[Translation done.]

PRIOR ART

[Description of the Prior Art] To the cellular phone with which spread remarkable in recent years is conspicuous, or an individual humanity news terminal (PDA:Personal DigitalAssitant), it is called for that the processing speed of a transistor is small, lightweight, and dramatically high to coincidence.
[0003] It is pointed out that the effect of the wiring delay in an electronic-circuitry substrate becomes large as the clock frequency of CPU goes up as the processing speed of a transistor increases namely.
[0004] Since wiring delay is proportional to the product of wiring resistance and wiring capacity, reduction of wiring resistance or wiring capacity is needed.
[0005] As a cure against wiring delay, it becomes the simplest cure approach to shorten wiring in a chip and between a chip as much as possible.
[0006] On the other hand, if wiring spacing becomes short, although the improvement in processing speed is expectable, another trouble actualizes.
[0007] It is the problem of EMI (electromagnetic-radiation interference noise: ElectroMagnetic Interference).
[0008] A wiring consistency becomes high, although wiring becomes short since electronic parts approach and they are arranged.
[0009] When a high-speed signal flows to the signal line which approached, an electromagnetic wave interferes each other by mutual electromagnetic induction, a noise is generated, and it becomes impossible consequently, for a signal to transmit correctly.
[0010] The cases conventionally driven by the high current are increasing in number under the effect to which low-battery-ization especially progresses at a mobile terminal, and we are anxious about the effect of EMI becoming larger.
[0011] in order to solve the problem of EMI -- essential -- electromagnetism -- the approach using optical wiring which has a non-guided advantage is proposed.
[0012] For example, the circuit board by which the electronic device and the light corpuscle child were integrated as shown in drawing 35 is shown in JP,2000-235127,A.
[0013] For 5201, as for a light-emitting part, 5206 light sensing portions, and 5207, in this drawing, an electronic integrated-circuit substrate and 5204 are [an optical-path converter and 5210] contact electrodes. 5211 is polyimide for making the circuit board 5201, and a light-emitting part and a light sensing portion rival. 5212 -- electric wiring and 5213 -- for a low reflecting layer and 5216, as for the 1st cladding layer and 5218, a polymer layer and 5217 are [a surface emission-type laser and 5214 / a photodiode and 5215 / a core layer and 5219] the 2nd cladding layer and the 5220 high reflective film.
[0014] The light inputted from the light-emitting part 5213 is received by the light sensing portion 5206, after being reflected by the optical-path converter, spreading the inside of a core layer 5218 in the direction of the arrow head 5221 in drawing and carrying out optical-path conversion again.
[0015] When the direction which input light spreads beforehand is defined, the configuration shown in above-mentioned drawing 35 can also transpose some electrical signal wiring to optical wiring.

[Translation done.]

EFFECT OF THE INVENTION

(Effectiveness) The effectiveness of this example is as follows.
(1) Thing (3) mounting which can be amplified and shaped in waveform in the electronic circuitry which can receive the light from the direction of two-dimensional arbitration, and by which thing (2) accumulation was carried out can lessen effect which it has on the easy electronic circuitry of thing (4) existing, and can consider as I/O of optical INTAKONEKUTO with one device. ((GaAs) Example 9:III-VNon ball)
This example uses a spherical GaAs substrate instead of a spherical Si substrate. In order to carry out lattice matching of the GaInNAs to GaAs, it has the features which can carry out band gap control simply rather than the case where Si substrate is used.
[0189] The manufacture approach is explained using drawing 24 .
[0190] (Production of Ball IC) IC3102 is produced like drawing 21 , the part (here Northern Hemisphere front face), for example, the semi-sphere surface section, of the undoping spherical Si substrate (1mmphi) 3101. In the case of a light emitting device, this IC is Actuation IC or is a parallel serial conversion circuit. In the case of a photo detector, they are a bias circuit, pre amplifier, a wave equalization circuit, or a serial parallel conversion circuit. When serving as both functions, of course, the electronic circuitry according to it is added.
[0191] These circuits are producible in usual FET or a usual Bipolar process. the inside of drawing 24 , and 3101 -- for a cladding layer and 3505, as for an electrode and 3507, a contact layer and 3506 are [a spherical semi-conductor substrate and 3501 / a buffer layer and 3502 / an aperture and 3401] selection masks.
[0192] (Production of an optical device) An optical device is produced after a GaAs ball IC process is completed mostly.
[0193] first, the ball whole -- a nitride etc. -- covering -- an optical device production part -- a flat surface -- polish -- and polishing is carried out. In a nitride, that of a wrap is for using it as a mask for selective growth in order to protect the electron device in an optical device process. It is desirable to form the film with small stress for the spherical surface for a wrap reason. As an optical device production field, the field (100) (it is the 4th page at (010), (-100), and all (0-10)) 3301 according to the field and it in the Southern Hemisphere (111) was used by this example (triangular flat surface of one-side about 20 um extent). Drawing 14 is the top view which looked at drawing 21 from the south pole. Drawing 23 is the sectional view of this one field. An aperture is opened only in a device production field after covering the whole by a nitride etc. again, if required. Since selective growth was carried out according to the configuration of opening, opening was controlled by this example to become cylinder-like.
[0194] The reason for having chosen the considerable (111) side here is as follows.
(1) Since it is chemically equivalent, uniform structure is producible with the crystal growth performed to a degree. (When it includes other crystal faces, an anisotropy arises in a presentation, thickness, and the crystal growth direction.)
(2) The field which touches the south pole (it is because the light from bleedoff or at least 4 directions

can be received for light in at least four directions to the propagation of light.) If it has a function more than the above and an EQC, it will not restrict to a considerable (111) side.

[0195] (Crystal growth) Device structure is explained using drawing 24 . the gas source MBE (molecular beam epitaxy) -- law or MOCVD (organic metal vacuum evaporationo) -- it carries out a laminating only to a selection field (opening) first using law, using GaAs as a buffer layer 3501. Next, the laminating of the InGaAs was carried out further, changing the presentation of In gradually for example, so that lattice matching may be carried out to In0.1Ga0.9As. Then, the laminating of the n-InAlGaAs cladding layer 3502, the GaInNAs/InAlGaAsMQW (multiplex quantum well) barrier layer (luminescence wavelength 1.3um) 3503, the p-InAlGaAs cladding layer 3504, and the p-InGaAs contact layer 3505 is carried out one by one. Since the process of this crystal growth is III-V groups' laminating, it has the features of being easier than the III-V group formation on Si of an example 8. Next, after attaching the aperture 3507 for optical ON outgoing radiation, a positive electrode 3506 is formed. The negative electrode is succeedingly formed in a desired location from the interior of a ball, an unnecessary nitride is removed, it wires with the electrode of IC, and this example is completed.

[0196] (Mounting) The example of mounting is shown in drawing 25 . In drawing, 3601 is substrates, such as PMMA, and 3602 is an optical waveguide core layer which consists of polyimide formed on it. The cladding layer 3603 which applied to PMMA correspondingly on it is formed. The hollow which can insert the above-mentioned spherical photoelectrical fusion device in this cladding layer 3603 and core layer 3602 is formed by FOTORISO etc. This device is fixed with ultraviolet-rays hardening resin etc. after it (not shown). Then, it is with the Au bump 3502 and a printed circuit 3501 and contact are taken.

[0197] (Principle of operation) When making it operate as a light-receiving device, it is the same as the case of the above-mentioned example. That is, it is incorporated by applying a reverse bias to an optical device by the electron device which the light which carried out incidence from the wide angle was absorbed by the PN junction from the optical entrance window, and approached as an electrical signal. Ga (In) Since the band gap is smaller than GaAs, NAs operates by the low battery rather than GaAs. Furthermore, since mobility is larger than Si, a high-speed response is possible.

[0198] Since GaInNAs is the compound semiconductor of a direct transition mold, it is usable also as a light emitting device. When making it operate as a light emitting device, in drawing 20 or drawing 22 , the light which emitted light by the PN junction is emitted to a wide angle from an optical outgoing radiation aperture by applying forward bias to the actuation electrode of a light emitting device. You may drive by the logic data itself and may drive through a driver circuit.

[0199] Since it has the spherical-surface configuration also in the light-receiving device, the case of a luminescence device is also a large include angle, and as for the front face, it has been the description with big outgoing radiation and incidence being possible.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in the case of the light from 5222 directions where the input light which spreads a core layer 5218 is shown by the arrow head all over drawing, for example, light cannot be received with the configuration of this drawing.
[0017] Then, in case this invention receives the light which spreads an optical transmission field, it aims at offering the semiconductor device which reduced direction dependency.
[0018] In addition, this invention also makes it the object to offer the luminescence device or light-receiving device which can be contributed to reduction of direction dependency (directivity).

[Translation done.]

MEANS

[Means for Solving the Problem] The photoelectron fusion equipment concerning this invention is photoelectron fusion equipment which has the light sensing portion which changes into an electrical signal the light which spreads an optical transmission field and this optical transmission field, and it is characterized by constituting this optical transmission field including the two-dimensional mold optical waveguide layer, and embedding this a part of light sensing portion [at least] to this optical transmission field.
[0020] The direction dependency of light-receiving sensibility at the time of receiving the light which spreads an optical transmission field by this invention can be reduced.
[0021] Moreover, in this invention, the laminating of the electric wiring layer can also be carried out on said optical transmission field. The laminating of the electric wiring layer may be carried out the whole surface on an optical transmission field. Of course, the laminating of the so-called semiconductor chip containing electric wiring can also be carried out on an optical transmission field. Said light sensing portion will intervene between a semiconductor chip and an optical transmission field at this case.
[0022] In addition, when a light sensing portion has a pn junction field and an PIN field, it is good to embed a part of field [at least] concerned to said optical transmission field. Of course, all of the fields concerned may be embedded substantially.
[0023] Said light sensing portion may be embedded to this optical transmission field so that direct light-receiving of the light which spreads the inside of said two-dimensional mold optical waveguide layer may be possible.
[0024] Said light sensing portion can also be embedded so that the light which spreads the inside of the field of said two-dimensional mold optical waveguide layer can be substantially received without directivity.
[0025] The part currently embedded to said optical transmission field of said light sensing portion is good to have the spherical field.
[0026] Said light sensing portion may be constituted including the spherical device.
[0027] The light-emitting part for transmitting light to said optical transmission field can also embed the part to this optical transmission field.
[0028] Said electric wiring layer located on this optical transmission field and another electric wiring layer located under this optical transmission field face across said optical transmission field, and, as for a part of mutual electric wiring layer [at least], it is also desirable that the beer which pierces through this optical transmission field connects electrically.
[0029] Either [at least] O/E conversion with the electron device formed on said electric wiring layer and said optical transmission field or E/O conversion can also be performed using a spherical device.
[0030] The photoelectrical fusion substrate concerning this invention is a substrate with which the electron device and the optical device have been arranged, and consists of two-layer at least. Moreover, to the 1st layer of this substrate The electric wiring which combines said electron device, said optical device, and these is arranged. Two-dimensional mold optical waveguide is formed in the 2nd layer of this substrate, said optical device has the light sensing portion which receives the light which is guiding

this two-dimensional mold optical waveguide, and it is characterized by embedding this a part of light sensing portion [at least] at this two-dimensional mold optical waveguide.
[0031] Said two-dimensional mold optical waveguide may be formed in the shape of a sheet.
[0032] Said light sensing portion has spherical structure, and this light sensing portion is mounted from this substrate front face so that it may be embedded at said optical waveguide, and on the front face of this substrate, said electric wiring and association, now Lycium chinense grow in it.
[0033] The electrical circuit which drives a light sensing portion and this to said optical device, or amplifies the electrical signal acquired may be formed.
[0034] Among said optical devices, the light source was mounted in this substrate from the front face so that a spherical configuration might be embedded at said optical waveguide of nothing and said substrate, and it may combine with said electric wiring on the front face of this substrate. It has the device for transmission and parallel signal line of spherical structure, and the output terminal of this parallel signal line is combined with said device for spherical transmission, and said substrate is carrying out parallel serial conversion with this device for transmission, and can also be sent out to said two-dimensional mold optical waveguide as a serial lightwave signal.
[0035] After receiving said serial lightwave signal by said light sensing portion embedded at said two-dimensional mold optical waveguide and being changed into an electrical signal, it can also be characterized by for serial/parallel conversion being carried out to this light sensing portion by the electronic circuitry formed simultaneously, and being transmitted to said parallel signal line.
[0036] Said photoelectrical fusion substrate can also consist of substrate ingredients (flexible sheet) with flexibility.
[0037] The photoelectrical fusion integrated circuit concerning this invention is a photoelectrical fusion integrated circuit with which the electron device and the optical device were accumulated on the spherical semi-conductor substrate front face, and this optical device is the photo detector constituted including the multilayer which includes pn junction radially, and it is characterized by having at least the amplifier with which this electron device amplifies the bias circuit which applies a reverse bias to this photo detector, and the signal which received light and was changed into the electrical signal.
[0038] Moreover, the electron device and the optical device are accumulated on the spherical semi-conductor substrate front face, this optical device is the light emitting device constituted including the multilayer which includes pn junction radially, and the photoelectrical fusion integrated circuit concerning this invention is characterized by having the bias circuit where this electron device applies forward bias to this light emitting device.
[0039] Moreover, after, as for the photoelectrical fusion integrated circuit concerning this invention, the electron device and the optical device are accumulated on the spherical semi-conductor substrate front face, and this optical device carries out flattening of said a part of spherical semi-conductor front face and sends two or more minute flat surfaces, On this minute flat surface, the laminating of the multilayer which includes pn junction radially is carried out, it is formed, and this electron device is characterized by having at least the bias circuit which applies a reverse bias or forward bias to this.
[0040] After carrying out flattening of said a part of spherical semi-conductor front face and sending two or more minute flat surfaces, in the process which carries out the laminating of the multilayer which includes pn junction radially on this minute flat surface, fields other than the minute flat surface of said spherical semi-conductor front face can be covered with a dielectric film etc., and the laminating of the multilayer which includes said pn junction selectively only at a minute flat surface with an organic metal epitaxial grown method or gas source molecular-beam vacuum deposition can be carried out.
[0041] The minute flat surface which comes to carry out flattening of said a part of spherical semi-conductor front face may be constituted from the crystal face near equivalence or a chemistry target by the crystal engineering target.
[0042]
[Embodiment of the Invention] The operation gestalt of this invention is explained using drawing 1 .
[0043] In drawing 1 , the optical transmission field where 1000 is constituted including the optical waveguide layer of a two-dimensional mold, and 1010 are light sensing portions which receive the light

which spreads this optical transmission field. The sectional view in AA' in drawing 1 is drawing 2 .
[0044] As shown in drawing 2 , offer of the semiconductor device which reduced the direction dependency of the light which this light sensing portion of the light which spreads an optical transmission field can receive by being embedded to the optical transmission field 1000 of a part of light sensing portion [at least] 1010 is attained.
[0045] An optical transmission field is formed by pinching a core layer by the cladding layer with a refractive index lower than this core layer. As an ingredient of a core layer, plastic material, such as optical plastics, such as PMMA (polymethylmethacrylate), a quartz system glass ingredient and polystyrene, and a polycarbonate, can be used. Although it is not limited as a cladding layer especially if a refractive index is lower than a core layer, polymer material, PCZ, ATON, etc. of fluorine content can be used, for example.
[0046] the line by which the propagation direction of light is beforehand determined to the one direction as the optical waveguide layer of a two-dimensional mold -- not waveguide but the waveguide of the shape of a field which can be spread in two or more directions of [within a field] is meant. In addition, in this invention, a two-dimensional mold optical waveguide layer may be called optical sheet.
[0047] A light sensing portion is the photo-electric-translation device which can perform O/E conversion. The photodiode of the so-called PN mold or an PIN mold is applicable. even if the PN-junction side is level on an optical sheet as a configuration of a light sensing portion -- abbreviation -- it may be vertical. It is good for the configuration of the light sensing portion of the part especially embedded to said optical transmission field to have a polyhedron or a spherical-surface configuration.
[0048] When embedding a light sensing portion to an optical transmission field, you may also embed a part of light sensing portion, and may also embed the all substantially. It is good to embed the PN-junction section at least at the core layer.
[0049] When the optical transmission field is constituted including the core layer and the cladding layer, it is good to embed the light sensing portion by Fukashi who reaches a core layer.
[0050] An electric wiring field can also be formed on the two-dimensional mold optical waveguide layer as an optical transmission field. The example is shown in drawing 3 .
[0051] In drawing 3 , it is the two-dimensional optical waveguide layer ("an optical sheet" is called hereafter.) by which 1101 was formed in the photoelectrical fusion substrate and 1102 was formed in the interior. The electron device (for example, they are CPU, RAM, a RF oscillator, etc.) with which 1103 and 1106 were formed on the electric wiring field 1108, the electric wiring by which 1104 was formed in the front face, and 1105 shown by the drawing Nakaya mark are optical wiring which the light which spreads the inside of said optical sheet forms. 1109 is a support substrate. Of course, what is necessary is just to form a support substrate if needed. Or the support substrate itself may function as a cladding layer. In this drawing, signs that a signal is transmitted to other electron devices 1107 etc. from an electron device 1106 using an optical sheet are shown.
[0052] For example, when optical wiring performs wiring to electron devices 1106-1107, the electrical signal from an electron device 1106 is changed into a lightwave signal by the E/O converter (not shown), and the optical sheet 1102 is made to diffuse the lightwave signal concerned. Although a lightwave signal is spread in the direction of an omnidirection within an optical sheet at a radial, it can also give a function to an optical sheet so that it may spread in the specific direction with which it is mainly concerned.
[0053] the lightwave signal which spread the inside of an optical sheet should pass an O/E converter (not shown) -- it is received by the electron device 1107. In this way, optical wiring is realized.
[0054] Moreover, by the original circuit pattern, in order to use the optical waveguide layer of a two-dimensional mold, even when the electron device 1107 does not exist, it can arrange in the location (for example, drawing 1) of the arbitration of the electric wiring field 1108. Of course, even if it calls it the location of arbitration, the free area for arranging an electron device 1107 is required.
[0055] And since the part is embedded at optical waveguide if there are few light sensing portions while being able to lessen effect of EMI by using optical wiring, it becomes possible to receive the signal light from various directions.

[0056] Furthermore, the light-emitting part which sends signal light to an optical sheet is also good to embed at least the part in an optical sheet again. The example is shown using drawing 4 . In this drawing, the electron device is drawn about the case where flip chip mounting is carried out. 1103 -- an electron device and 1104 -- for a metal bump and 1205, as for a core layer and 1207, an up cladding layer and 1206 are [a metal wiring field and 1201 / a light sensing portion and 1202 / a lower cladding layer and 1208] light-emitting parts. 1210 shows signs that the light to spread is received by the light sensing portion 1201. 1203 shows signs that the electrical signal which carried out O/E conversion of the light which received light by the light sensing portion is transmitted to an electron device. 1211 shows signs that the light which spreads the inside of a core layer 1206 from a light-emitting part 1208 is transmitted.
[0057] In drawing 4 , since a part of light-emitting part 1208 is embedded at a core layer 1206 and the spherical device (it mentions later for details.) is used, light spreads so that it may be spread in the field inboard in a core layer.
[0058] In addition, the production approach of Ball IC is performed as follows, for example.
(1) Produce Si ball first. The granular polycrystal Si is put in into a pipe with a diameter of 2mm, and is fused, and it is mostly made a globular form single crystal. Then, surface polish is performed in the way which produces a ball bearing, and it is made the real ball of 1mmphi.
(2) Next, it lets the inside of IC process pipe pass, and perform oxidation and a diffusion process. Pattern baking is realizable by the approach currently indicated by JP,10-294254,A and JP,11-54406,A. In the former, it has a circuit pattern corresponding to the spherical surface of Si ball ingredient, and one-shot exposure of this circuit pattern is carried out to the field more than one half of all the spherical surfaces over the spherical surface of this Si ball ingredient. In the latter, the exposure field of the spherical IC front face corresponding to this angle of rotation is exposed using the mask corresponding to this, fixing the shaft passing through the core of spherical IC to arbitration, and rotating spherical IC intermittently centering on this shaft. The Si ball IC is completed at the process so far.
[0059] In addition, to two-dimensional optical waveguide, effectively, light can also be additionally used for a mirror, prism, a grating, a hologram, etc., outgoing radiation or in case incidence is carried out.
[0060] In addition, as a spherical semi-conductor member used for this invention, it can constitute from ingredients, such as Si, GaAs, InP or GaN, germanium and AlN, SiGe, and GaAsN. Of course, although it is desirable that it is a single crystal as for these ingredients, when functioning enough as a light sensing portion or a light-emitting part, you may be polycrystal or an amorphous substance.
[0061] As a multilayer which constitutes said photo detector or light emitting device, it can constitute, for example from p-Si/i-Si/n-Si, can constitute from p-GaAs/GaAsN/n-GaAs, or can constitute from p-(aluminum, Ga) (As, P, N)/i-(aluminum, Ga) (As, P, N)/n- (aluminum, Ga) (As, P, N).
[0062] In addition, (C (A, B), D, E), in a publication, A and B show an III group element and C, D, and E show V group element. (A, B) A publication expresses AxB1-xCyDzE1-y-z (C, D, E).

[Translation done.]

EXAMPLE

[Example] (Example 1: Optical sheet + spherical mold light-receiving device) The 1st example is explained using drawing 1 , drawing 2 , drawing 5 , and drawing 6 . PMMA which is optical plastics was used as a core layer of an optical transmission medium 1000. Polyimide was used as a cladding layer formed so that this core layer may be pinched. The thickness of the whole optical transmission medium was about 0.8mm (0.2mm of core layers, 0.3mm of cladding layers), and magnitude was 30x30mm. In addition, the concrete manufacture approach of an optical transmission medium is mentioned later.
[0064] A spherical device can be used as a light sensing portion 1010.
[0065] The typical sectional view of a spherical light device was shown in drawing 5 . In this drawing, 1501 is a spherical p mold Si member. In addition, the Si ball itself is obtained by performing surface polish in the way which produces a ball bearing, and making it a real ball, after fusing for example, the granular polycrystal Si and making it a globular form single crystal mostly. On the spherical Si member 1501, as the 1st cladding layer 1502, it grows up considering P type AlGaAsN as a barrier layer 1503, and the n mold AlGaAsN is grown up as Undoping GaAsN and the 2nd cladding layer 1304.
[0066] The compound semiconductor of a GaAsN system was used here because it was easy to carry out lattice matching of the band gap to excelling in the temperature characteristic small to GaAs, and also Si.
[0067] Of course, a light sensing portion (photodiode) is produced not growing up a compound semiconductor thin film, growing up the silicon thin film of N type into a P type spherical silicon front face, and forming a PN junction on spherical Si. Moreover, ion-implantation and a diffusion method (thermal diffusion or solid phase diffusion) may be used instead of making a PN junction with thin film growth.
[0068] The anode 1505 electrically connected with the cathode 1504 through the beer hall 1506 is formed in the pole section of this ball IC. A beer hall 1506 can be formed by etching or laser processing.

[0069] A light sensing portion 1010 is embedded next at an optical transmission medium. As shown in drawing 6 , specifically, it embeds even at extent which reaches a cladding layer 1605 and a core layer 1606. 1607 is a cladding layer.
[0070] In order to embed a light sensing portion, it is necessary to make the hole corresponding to an embedding field in an optical transmission medium. the metal mold of the metal for drilling -- heat -- the hole corresponding to a light sensing portion is formed by pushing against an optical transmission medium the back the bottom. The semiconductor device said to this invention is done by embedding a light sensing portion 1010 in the formed hole. A light sensing portion 1010 is applying a reverse bias between a cathode 1504 and an anode 1505, and the light which carried out incidence is absorbed by the PN junction, and is obtained as an electrical signal.
[0071] As explained above, the semiconductor device with which the direction dependency (directivity) of the light which spreads an optical transmission medium was reduced remarkably is produced. Moreover, a light sensing portion can receive directly the light which has transmitted the optical

transmission field.
[0072] In addition, although the spherical device was used as a light sensing portion, the usual photodiode which is not spherically limited if it can embed at an optical transmission medium, and has a PN junction may be used.
[0073] Moreover, with a light sensing portion, you may also produce a light-emitting part with a spherical device, and may also embed the part at an optical transmission medium. Furthermore, it is also possible to form an electric wiring layer on [whole] an optical sheet. The above-mentioned optical sheet is beforehand prepared in the lower layer of the printed circuit board for electric wiring, and it is also a desirable gestalt to carry out some wiring to optical wiring if needed.
[0074] (Example 2: The additional approach of an electron device) In view of the direction dependency of a light sensing portion being reduced in this invention, the additional approach of the following electron devices is possible.
[0075] It explains using drawing 9 from drawing 7 . In drawing 7 , 1750 shows the photoelectrical fusion substrate. As for an optical transmission medium and 1720, an electric wiring layer, and 1707 and 1705 is [1700] electron devices. 1705 is equipped with the light-emitting part (not shown) with possible making an optical transmission medium 1700 spread signal light. 1720 is an electric wiring layer (for example, printed circuit board).
[0076] If it does not have the optical transmission medium when newly adding an electron device 1706 to the photoelectrical fusion substrate 1750 at a free area 1730, an electron device 1706 only must be added and electric wiring must be performed between each devices. However, in the case of the photoelectrical fusion substrate 1750, optical wiring can be used for between an electron device 1705 and 1706. In drawing 7 , 1780 is a light sensing portion produced by the approach as stated above.
[0077] The optical transmission medium 1700 forms the hole for embedding beforehand, as shown in drawing 8 . One or plural are sufficient as the embedding's hole. From a viewpoint of the degree of freedom of arrangement, it is good to form two or more holes beforehand. For example, a hole is formed in the shape of an array. In drawing 8 , 1741 is a hole to embed the light-emitting part of an electron device 1705. In addition, the hole 1744 which is not used can also be filled with resin etc. It is effective when the light which spreads the inside of an optical transmission medium is superfluously scattered about by the intact hole. In addition, it is also desirable to give a difference to the etching property of the resin which fills a hole, and its perimeter so that it may be easy to remove the packing of a hole.
[0078] In adding an electron device 1706 in this example, a hole 1740 is used.
[0079] As shown in drawing 9 , the field which is going to add an electron device 1706 is removed and a hole 1740 is exposed. Of course, this process can be skipped when the electric wiring layer 1720 is not formed in the field of 1730 shown in drawing 7 . Then, when packing is in a hole 1740, etching etc. removes it. And this device is added so that the light sensing portion 1780 of an electron device 1706 may be embedded in a hole 1740. An electron device 1705 becomes possible [connecting the part between 1706 with an electron device 1705 with optical wiring] using the optical transmission object 1700 which was not used until an electron device 1706 is added, since it has the light-emitting part.
[0080] When newly adding a device to a very small printed circuit board which is built in a cellular phone according to this example, optical wiring can be used and the effect of EMI accompanying addition of an electron device can be reduced.
[0081] When it is newly going to add an electron device on the assumption that the existing circuit pattern, the existing circuit group may be influenced of EMI with the electron device newly added. In this case, optical wiring can be used like this example.
[0082] Although optical wiring is possible also for a configuration as shown in drawing 35 if linear waveguide is beforehand formed corresponding to the location of the electron device newly added, now, the degree of freedom of arrangement will become very low. It is because the additional location of a new device is dependent on the linear waveguide location currently formed beforehand. By using the optical waveguide of a two-dimensional mold like this example, optical high wiring of the degree of freedom of device arrangement is attained.
[0083] (Example 3: Photoelectricity two-layer substrate + spherical light I/O device) Drawing 3 is a

typical perspective view for explaining the example of this invention.
[0084] The two-dimensional optical waveguide layer ("an optical sheet" is called hereafter.) by which 1101 was formed in the photoelectrical fusion substrate and 1102 was formed in the interior in drawing 3 , the electron devices (for example, CPU, RAM, a RF oscillator, etc.) with which 1103, 1106, and 1107 were formed in the front face, the electric wiring by which 1104 was formed in the front face, and 1105 are optical wiring which the light which spreads the inside of said optical sheet forms.
[0085] First, the production approach of an optical sheet is explained.
[0086] Although the structures of an optical sheet will not be a predetermined distance and the thing limited about light especially if it can transmit, what fulfills the following conditions is more desirable.
(1) Have the two-dimensional slab mold optical waveguide which guides light.
[0087] Although propagation loss is better as it is small, it depends for it on a transmission distance. For example, if it is the thing of 0.1 dB/cm, the substrate of several cm angle can be used.
(2) Electric wiring is producible on a front face.
[0088] This is for employing the conventional electric circuit pattern efficiently as it is.
[0089] What fills the above (1) and (2) with using organic resin, such as polyimide, for an optical waveguide layer is obtained using PMMA as a support substrate and a cladding layer. In addition, as for an optical transmission layer, it is desirable to have prepared the whole surface under an electric wiring layer.
[0090] The sectional view in the B section in drawing 3 is shown in drawing 4 . An electron device 1103 explains the case where optical INTAKONEKUSHON is performed using the optical sheet 1102. In this drawing, the case where the light sensing portion 1201 and the light-emitting part 1208 have dissociated from the electron device 1103 is shown. Of course, the light sensing portion and the light-emitting part may be built in electron device 1103 the very thing.
[0091] As for a resin substrate (** cladding layer) and 1205, 1207 is [a cladding layer and 1206] core layers with a refractive index higher than 1205 and 1207. Although each thickness was made into 0.5mm of substrates, 0.1mm of core layers, and 0.3mm of cladding layers, it is not restricted to such sizes.
[0092] It is the optical sheet which unified these three layers. It can consider as a flexible substrate strong against bending by applying a core layer and a cladding layer and using the polyimide resin which can form membranes, using the PMMA substrate which has flexibility in a substrate.
[0093] In this example, the optical I/O device (spherical light device) formed with the compound semiconductor on the spherical Si substrate is used.
[0094] This spherical light device is explained briefly (the matter relevant to a spherical device is indicated by JP,12-31190,A).
[0095] The mimetic diagram of a spherical light device was shown in drawing 5 . As for a spherical p mold Si substrate and 1502, in this drawing, 1501 is [a P type AlGaAsN cladding layer, a 1503 undoping GaAsN barrier layer and 1504] n mold AlGaAsN cladding layers. It is [that one band gap is small excellent in the temperature characteristic, that it is easy to carry out lattice matching to 2Si, and] to have used the compound semiconductor of a GaAsN system here. Other ingredient systems including a substrate may be used.
[0096] The anode 1505 connected with the cathode 1504 through the beer hall 1506 is formed in the pole section of this ball IC. In this example, it is good also as structure which is different in a light emitting device and a photo detector although the thing of this structure was used. As for a cathode 1504, it is desirable to have aperture structure and mesh structure in order to output and input light.
[0097] In carrying out ball IC actuation as a light emitting device, by applying forward bias between a cathode 1504 and an anode 1505, a carrier is poured into a PN junction and emits light. The light which emitted light is emitted to a wide angle from an optical outgoing radiation aperture.
[0098] On the other hand, it is incorporated by the electron device which the light which carried out incidence from the wide angle was absorbed by the PN junction from the optical entrance window, and approached as an electrical signal by applying a reverse bias between a cathode 1504 and an anode 1505, in making it operate as a photo detector.

[0099] Since it has the spherical-surface configuration also in the light-receiving device, the case of a luminescence device is also a large include angle, and as for the front face, it has been the description with big outgoing radiation and incidence being possible.
[0100] In addition, the ball IC of this example can carry out simultaneous production not only of the optical I/O section but other ICs. It is indicated [approach / of IC / production] by JP,10-294254,A (U.S. Pat. No. 6097472 official report) "a spherical device aligner and the manufacture approach" etc. about the exposure approach etc.
[0101] In this example, the 3.3V actuation pre amplifier of a CMOS configuration was used as an object for photo detectors.
[0102] Next, the mounting approach of this spherical light device is explained using 12 from drawing 10 .
[0103] First, the hole of the shape of a possible semi-sphere of inserting said ball IC in said optical sheet substrate is made. The method of opening is arbitrary and good. You may form in the location beforehand regular using a photolithography and etching, and a hole may be formed in the location of arbitration according to an individual using laser etc. The heat dissolution process was used in this example.
[0104] This was heated by having used the ball of metal as metal mold 2000 like drawing 10 , it pressed against the above-mentioned resin substrate 1207 (drawing 11), and the semi-sphere-like impression 2100 was produced (drawing 12). The depth was carried out until it reached near the core layer of an optical wiring substrate. Of course, extent in which a hole reaches the core layer bottom may be hollowed.
[0105] As shown in drawing 4 , after printing electric wiring 1104 on an optical sheet after the process concerned, the electron device represented by LSI is mounted. Although this mounting approach could be arbitrary, the flip chip mounting method was used here.
[0106] Next, it mounts so that the optical I/O section may become the impression of an optical sheet at the bottom of an impression. Alignment is carried out and it fixes so that optical ejection and optical incorporation may be possible and the optical I/O section may touch the bottom of an impression (refer to drawing 13). Since it is the spherical surface in the case of this example, a fine alignment precision is not needed. After performing alignment of an impression 2100 and a spherical device, it fixed with ultraviolet-rays hardening resin etc.
[0107] The electron device which carried out the surface mount to the spherical light I/O device is connected with the last by print electric wiring. To this, a bump or plating is desirable. Drawing 13 is a bump 2302 and shows the example which connected the printed circuit 1104 and the electrode 1504.
[0108] In addition, although E/O and the example using spherical IC as an O/E converter were shown, it is not limited to this.
[0109] (Principle of operation) The principle of operation is explained below.
[0110] First, a transmitting function is explained.
[0111] Drawing 4 is the enlarged drawing of the A section of drawing 3 . In drawing 4 , the output electrical signal (CMOS logic) of the I/O section of LSI1103 can transmit a signal to a nearby electron device through electric wiring 1104.
[0112] However, it is also possible to carry out the direct drive of the optical I/O device (for example, spherical light device) which approached, to generate the output lightwave signal 1211, and to use as optical wiring through the optical waveguide layer (optical sheet) 1206. One of approaches can also be chosen if needed.
[0113] The case where the spherical light device which approached is driven is considered.
[0114] The logic signal (for example, if it is CMOS 3.3 V) of LSI is sufficient electrical potential difference to drive said spherical light device. An electrical signal is changed into a lightwave signal by impressing a logic signal so that it may become a spherical light device with forward bias.
[0115] Since light is emitted to the whole spherical surface at this time, diffusion propagation is carried out without special optical system all over the optical sheet. Consequently, the joint effectiveness to waveguide can secure 80% or more.

[0116] Next, a reception function is explained.
[0117] If the input lightwave signal 1210 spread from the direction of the arbitration of the optical sheet 1206 arrives at the front face of the spherical photo detector 1201, it will be incorporated inside, it is absorbed near the PN junction to which the reverse bias was applied, and is changed into an electronic signal.
[0118] The changed electrical signal is incorporated and processed to the LSI1103 interior which approaches as an input electrical signal 1203. under the present circumstances -- if the pre amplifier which amplifies an electrical signal is accumulated on the spherical light device front face -- CMOS -- it can restore to a compatible electrical potential difference.
[0119] If this invention is used as mentioned above, while being able to reduce the direction dependency of a light sensing portion.
[0120] In addition, when two or more metal wiring approaches mutually, and is arranged and high-speed data transmission (for example, 1Gbps) is performed, the strength of the electromagnetic radiation noise of the near is expressed with "strength of source of release" (frequency, wave, actuation current) x"transfer constant (resonance-with power-source line, association with approaching line)" x "an antenna factor (a connector, electrode)."
[0121] That is, a noise level becomes high, so that a signal pulse is so close to a square wave that the speed of a signal is so quick that a current value is so large that a wire length is long.
[0122] Therefore, when using metal wiring near [CPU for which high-speed processing is needed], EMI cannot be removed fundamentally.
[0123] It is possible to improve these by on the other hand using light for wiring like this example. It is because there is no electromagnetic induction, so a transfer constant becomes zero in optical wiring.
[0124] Like this example, by separating into two-layer, and arranging an electric wiring layer and an optical transmission layer, and making this optical transmission layer into two-dimensional optical waveguide (optical sheet), the effect of EMI by the specific device can be prevented, and a production process can also especially offer an easy photoelectrical fusion wiring substrate.
[0125] The physical magnitude which wiring of per one of optical wiring takes on the other hand is large single or more figures compared with electric wiring, when using optical waveguide (the so-called single dimension type of waveguide). So, size becomes large or, as for changing all electric wiring into optical wiring, the direction of a demerit, like loss by bending becomes large becomes large.
[0126] Furthermore, there is also a demerit which is obliged to modification of the conventional electric circuit pattern by introducing optical wiring.
[0127] At this example, the two above-mentioned demerits are improved by making this optical transmission layer into two-dimensional optical waveguide (optical sheet). The degree of freedom of arrangement is raised by applying two-dimensional waveguide (sheet-like optical waveguide) to the optical waveguide used as optical wiring. Moreover, in transmitting light to an optical sheet from a light-emitting part, although optical data are transmitted in all the directions two-dimensional from the luminescence device concerned, it can do.
[0128] In addition, it is desirable that light can be emitted to the omnidirection of 2D and the light from the omnidirection of 2D can be received as a light-receiving device as a luminescence device connectable with two-dimensional optical waveguide. The device concerned is an optical device produced for example, on the spherical surface.
[0129] When the front face of a photo detector is made spherical, a device design can be carried out so that the light from all bearing can be received. This appears as a relaxation effect with a large mounting precision, in case propagation incorporates the light of the waveguide of immobilization.
[0130] It can be made to operate as an optical I/O component by this spherical device independent by a bias circuit making an amplifying circuit to a spherical optical device. This lessens effect which it has on the design of the conventional electronic circuitry, and can realize optical INTAKONEKUTO.
[0131] (Example 4: Clock distribution) The application of this invention is explained below.
[0132] In drawing 3 , two or more electronic parts (CPU, memory, etc.) 1103 are mounted on one substrate 1101, and the case where a part of the wiring has combined with the substrate with the

spherical light device 1201 like an example 3 is considered.
[0133] drawing 3 -- it is and let LSI1106 be a clock generator.
[0134] At this time, a signal is sent for a clock signal to the optical waveguide section of a photoelectrical fusion substrate through the spherical light device 1208 (drawing 4). The signal which had optical wiring chosen is outputted to a spherical light device, and this is driven by the signal itself sent with CMOS. A driver does not need specially. Therefore, the semiconductor laser of the GaAsN system which operates by the low battery as an optical device is used.
[0135] The spherical light device 1208 changes a clock signal into light, and distributes the clock signal which turned into a lightwave signal at all the devices on a substrate. Since the electron device (for example, MPU1103) of the arbitration on a substrate also has the spherical light device 1201, it receives the lightwave signal from a clock generator 1106. Since the spherical light device 1201 has the spherical-surface configuration, it can receive the light from the direction of arbitration at high light-receiving effectiveness.
[0136] The light which received light is divided into an electron and a hole pair, and by the pre amplifier produced by a spherical light device top or approaching LSI, an electrical signal is amplified and it is incorporated by MPU. Since other devices (for example, RAM) can receive a clock signal by the same approach, it can be made to operate with a common clock.
[0137] according to [although effect of EMI by wiring delay or high-speed high current actuation was not able to be conventionally disregarded since a circuit pattern was not able to be chosen freely, or since wiring distance was not made to isometry when it was going to distribute the clock signal to each device] this example -- optical wiring -- using -- the minimum distance -- and electromagnetism -- since it can wire by no guiding, these troubles are solvable at once.
[0138] (Example 5:MPU -> memory (serial transmission)) Other applications are explained below.
[0139] Drawing 14 is a mimetic diagram for explaining the example of this invention. In drawing, 2407 and 2408 are two CPUs. 2409 is RAM which these two CPUs share. In this drawing, the electric wiring for parallel transmission in 2401 and 2402 are optical wiring for serial transmissions.
[0140] In the usual electric wiring, the data line 2401 of 64-bit width of face is needed in six transmission lines, for example.
[0141] For the application sent at a mass data high speed, data may be unable to be correctly sent for the reason (wiring delay and EMI) explained previously in the conventional wiring (animation etc.). In such a case, optical wiring can be used. Specifically, the optical wiring 2402 is used for all or a part of exchanges of a signal between CPU and RAM.
[0142] Moreover, in drawing 14 , the case where 2400 is MPU and 2407 and 2408 are memory is considered. In order to send data to memory by 64-bit width of face from MPU, as electric wiring, six are required, but parallel serial conversion is carried out in the last stage of MPU, and after being connecting one optical I/O component, transmitting an electrical signal in the optical waveguide section of a photoelectrical fusion substrate as a lightwave signal and receiving light with the optical I/O component by the side of a receptacle, it is carrying out serial parallel conversion, and considers as the parallel signal of 64-bit width of face. Although a clock becomes high by carrying out serial conversion from parallel, in order to spread to optical waveguide, there are no worries about EMI.
[0143] Although optical wiring is chosen from the beginning in this example, it is not necessary to necessarily use only optical wiring. That is, it is possible to connect as optical wiring by enabling it to also choose the pass of electric wiring at electric wiring and a certain time at a certain time. This flexibility is one of the features of this invention.
[0144] In electric wiring, since EMI is avoided, it may wire so that other devices may be avoided, and as a result, a wire length may become long, and it may become the cause of wiring delay or waveform distortion shortly. Since connection of an EMI free-lancer can be performed by the shortest by choosing optical wiring at this time, wiring delay does not produce waveform distortion, either.
[0145] As for which signal is made electric wiring or optical wiring, the device which manages a bus determines the last decision.
[0146] The light changed into light diffuses and spreads the inside of the optical waveguide of 2D, and

reaches to IC arranged in the other place. The ball IC for O/E conversion is installed also near [this] the IC. This example installed the same ball IC. Since direct light hits a pn junction side even if it uses neither prism nor a mirror, since the front face is carrying out the shape of a globular form, it can mount very simple.
[0147] (Example 6: Accumulate pin-PD and amplifier on Ball Si) Drawing 15 is a mimetic diagram for explaining the example concerning this invention.
[0148] In drawing, 2508 is a spherical Si substrate, the Northern Hemisphere section shows a front face, and the Southern Hemisphere section shows the sectional view. The photo detector by which 2509 was formed in the Southern Hemisphere section, and 2503 are ICs, such as pre amplifier which amplifies the bias circuit which drives it, and an electrical signal. 2510 [in addition,] -- an optical waveguide substrate and 2506 -- for an electrode and 2512, as for a bump and 2511, a printed circuit and 2504 are [a core layer and 2505 / a cladding layer and 2506 / output light and 2507] input light.
[0149] Hereafter, the manufacture approach of the semiconductor device shown in drawing 15 is explained.
[0150] first, drawing 16 -- like -- the undoping spherical Si substrate 2601 (diameter about 1mmphi) -- mostly, in one half (Southern Hemisphere section), by the ion implantation, the p-Si layer 2521, the i-Si layer 2509, and the n-Si layer 2520 are formed, and it considers as a photo detector field. The depth is 0.3um extent, respectively. Annealing treatment performs crystal recovery if needed.
[0151] Next, as shown in drawing 17 (an upper half expresses a ball front face and the lower half expresses the ball cross section), the bias circuit 2701 for applying a reverse bias to this photo detector to the remaining ball surface fields (Northern Hemisphere section), the pre amplifier circuit 2702 amplified to the voltage level of a request of the electrical signal changed from the lightwave signal, and waveform shaping circuit 2703 grade are produced. In addition, as for electric wiring and 2705, 2704 is [a photo detector electrode and 2506] electronic-circuitry electrodes. Since it is an electrode for an electrode 2705 to impress 2521 to the n-Si layer 2520, and for 2706 impress an electrode to a p-Si layer, respectively, the potential of an electrode 2705 is made not to be impressed to the n-Si layer 2520.
[0152] Here, all electronic circuitries are 3.3V. A CMOS logical circuit is used. Simultaneously, the positive electrode 2705, the negative electrode 2706, and the circuit pattern 2704 of a photo detector are formed. Moreover, 2506 is an external electrode for electronic-circuitry I/O.
[0153] An example of the mounting approach is shown below. In drawing 15 , 2510 is the cladding layer which served as the substrate made in PMMA, and the core layer (it has become sheet-like) from which 2506 becomes optical waveguide, and 2505 are cladding layers. A core layer 2506 and a cladding layer 2505 apply photosensitive polyimide etc., and the spherical photoelectrical fusion device of this invention produces the hollow which can be inserted in with a HOTORISO technique etc. After printing a desired circuit pattern on besides, the photoelectrical fusion device of this invention is fixed with ultraviolet-rays hardening resin (not shown).
[0154] Then, as shown in drawing 18 , contact to a circuit pattern 2803 and the electrode 2506 on a device is taken using Au bump 2804 grade. Plating may be used for this process instead of a bump.
[0155] The principle of operation is explained below.
[0156] In drawing 15 or drawing 17 , a reverse bias (for example, 3.3V) is applied to the pn junction of a photoelectrical fusion device by the bias circuit 2701. At this time, this photoelectrical fusion device can receive the lightwave signal which spreads the inside of the two-dimensional optical core layer 2506 from the direction of arbitration. This is because a part of light sensing portion [at least] is embedded at the optical transmission medium.
[0157] An input lightwave signal is incorporated inside, is absorbed near the PN junction to which the reverse bias was applied, and is changed into an electronic signal. After the changed electrical signal was amplified to the CMOS logic level by the pre amplifier 2702 which approaches as an input electrical signal and it is further processed in the 2701 grades of waveform shaping circuit drawing 17 , it is transmitted to the printed circuit contacted by the bump.
[0158] As mentioned above, according to the explained example, the light from the direction of (1) two-dimensional arbitration is receivable, magnification and waveform shaping can be performed and (3)

mounting becomes easy in the electronic circuitry by which (2) accumulation was carried out. furthermore, the effect which it has on the electronic circuitry of (4) existing -- it can lessen and can consider as I/O of optical INTAKONEKUTO with one device.
[0159] (example 7:III-VN on Ball GaAs) This example uses a spherical GaAs substrate instead of a spherical Si substrate.
[0160] The manufacture approach is explained using drawing 19 .
[0161] From the front face of the high grade undoping spherical GaAs substrate 2901, a 2902p mold GaAs layer, a 2903GaAsN optical absorption layer, and a 2904n mold GaAs layer are formed by the ion implantation.
[0162] The high impurity concentration of 1E19cm-3 and n mold of the high impurity concentration of p mold is about [one E18cm -] three (an ion kind can be set to arbitration). Undoping GaAsN consists of carrying out the ion implantation (for example, 1E21cm-3) of the N to high concentration to GaAs. RTA (Rapid Thermal Annealing) is effective in order to remove the damage at the time of an ion implantation.
[0163] The impregnation depth set up the ion-implantation conditions of other layers so that a GaAsN layer might serve as thickness 0.2um.
[0164] A next process and a next mounting process apply to an example 6.
[0165] The electronic-circuitry section can produce the electronic circuitry which has an example 6 and a function more than equivalent by carrying out in a Bipola process. Not perfect aperture structure but mesh structure is sufficient as an electrode.
[0166] Hereafter, it explains focusing on a different point from an example 6.
[0167] When making it operate as a light-receiving device, it is the same as the case of an example 6. That is, it is incorporated by the electron device which the light which carried out incidence from the wide angle was absorbed by the PN junction from the optical entrance window, and approached as an electrical signal by applying a reverse bias to the p-GaAs layer 2902 and the n-GaAs layer 2904 in drawing 19 , respectively. Since the band gap is smaller than GaAs, GaAsN operates by the low battery rather than GaAs.
[0168] Furthermore, since mobility is larger than Si, a high-speed response is possible. In addition, 2903 is an i-GaAsN layer.
[0169] Since GaAsN is the compound semiconductor of a direct transition mold, it is usable also as a light emitting device. When making it operate as a light emitting device, in drawing 15 or drawing 17 , the light which emitted light by the PN junction is emitted to a wide angle from an optical outgoing radiation aperture by applying forward bias to electrodes 2705 and 2706. You may drive by the logic data itself and may drive through a driver circuit.
[0170] Since it has the spherical-surface configuration also in the light-receiving device, the case of a luminescence device is also a large include angle, and as for the front face, it has been the description with big outgoing radiation and incidence being possible.
[0171] (example 8: GaAsN films - facets of Ball Si)
Drawing 20 is a mimetic diagram for explaining this example.
[0172] This example carries out the laminating of GaAsN/AlGaAsN to a ball Si substrate, and is taken as a light emitting device or a photo detector. 3101 -- a spherical semi-conductor substrate and 3102 -- IC and 3103 -- an optical device and 3104 -- for a core layer and 3107, as for a printed circuit and 3109, a cladding layer and 3108 are [a bump and 3105 / an optical waveguide substrate and 3106 / output light and 3110] input light.
[0173] Hereafter, the manufacture approach is explained.
[0174] (Production of Ball IC) Like drawing 21 , IC3102 is produced on the semi-sphere front face (here Northern Hemisphere front face) of the undoping spherical Si substrate (1mmphi) 3101. In the case of a light emitting device, this IC is Actuation IC or is a parallel serial conversion circuit. In the case of a photo detector, they are a bias circuit, pre amplifier, a wave equalization circuit, or a serial parallel conversion circuit. When serving as both functions, of course, the electronic circuitry according to it is added. Being able to produce these circuits by the usual CMOS process, the logic electrical potential

difference is 3.3V. 3111 is electric wiring.
[0175] (Production of an optical device) An optical device is produced after an Si ball IC process is completed mostly.
[0176] first, the ball whole -- a nitride (SiN) etc. -- covering -- an optical device production part -- a flat surface -- polish -- and polishing is carried out. In a nitride, that of a wrap is for using it as a mask for selective growth in order to protect an electron device in an optical device process. It is desirable to form the film with small stress for the spherical surface for a wrap reason (here, Si3N4 (200nm in thickness) was used).
[0177] As an optical device production field, the field (100) (it is the 4th page at (010), (-100), and all (0-10)) 3301 according to the field and it in the Southern Hemisphere (111) was used by this example (triangular one-side about 20-micrometer flat surface). Drawing 22 is the top view which looked at drawing 21 from the south pole, 3101 is a spherical substrate and 3301 is a considerable (111) side.
[0178] Drawing 23 is the sectional view of this one field. An aperture is opened only in a device production field after covering the whole by a nitride etc. again, if required. Since selective growth was carried out according to the configuration of opening, opening was controlled by this example to become cylinder-like. As for a spherical semi-conductor substrate and 3301, 3101 is [a field (111) and 3401] SiN films.
[0179] The reason for having chosen the considerable (111) side here is as follows.
(1) Since it is chemically equivalent, uniform structure is producible with the crystal growth performed to a degree. (When it includes other crystal faces, an anisotropy arises in a presentation, thickness, and the crystal growth direction.)
(2) The field which touches the south pole (it is because the light from bleedoff or at least 4 directions can be received for light in at least four directions to the propagation of light.) If it has a function more than the above and an EQC, it will not restrict to a considerable (111) side.
[0180] (Crystal growth) Device structure is explained using drawing 24 . the gas source MBE (molecular beam epitaxy) -- law or MOCVD (organic metal vacuum evaporationo) -- it carries out a laminating only to a selection field (opening) first using law, using GaNxAs 1-x as a buffer layer 3501. What is necessary is just to choose the lattice constant at this time suitably according to the conditions of a cladding layer and a barrier layer.
[0181] Here, after changing the nitrogen presentation X gradually from 0.2 to 0 so that lattice matching may be carried out to In0.1Ga0.9As, the laminating of the InGaAs was carried out further, changing the presentation of In gradually. Then, the laminating of the n-InAlGaAs cladding layer 3502, the GaInNAs/InAlGaAsMQW (multiplex quantum well) barrier layer (luminescence wavelength 1.3um) 3503, the p-InAlGaAs cladding layer 3504, and the p-InGaAs contact layer 3505 is carried out one by one. After attaching the aperture 3507 for optical ON outgoing radiation, a positive electrode 3506 is formed. The negative electrode is succeedingly formed in a desired location from the interior of a ball, an unnecessary nitride is removed, it wires with the electrode of IC, and this example is completed. 3101 is a spherical semi-conductor substrate and 3401 is a selection mask.
[0182] (Mounting) The example of mounting is shown in drawing 25 . In drawing, 3601 is substrates, such as PMMA, and 3602 is an optical waveguide core layer which consists of polyimide formed on it. The cladding layer 3603 which applied to PMMA correspondingly on it is formed. The hollow which can insert the above-mentioned spherical photoelectrical fusion device in this cladding layer 3603 and core layer 3602 is formed by FOTORISO etc. This device is fixed with ultraviolet-rays hardening resin etc. after it (not shown). Then, a printed circuit 3501 and contact are taken using the Au bump 3502.
[0183] (Principle of operation) The principle of operation is explained below.
[0184] (in the case of a light emitting device) In drawing 20 or drawing 21 , a light emitting device 3103 emits a lightwave signal with the electrical signal supplied from a driver IC 3102. This lightwave signal is emitted to the mounted core layer as an output light. Since direct optical coupling is carried out to the core layer, light can be efficiently led to optical waveguide.
[0185] What is necessary is to modulate the same signal simultaneously and just to take out a lightwave signal to send out a lightwave signal to a two-dimensional omnidirection. In a current case, it is 4

bearing, but since this light emitting device is LED, since directivity is weak, it is uniformly spread by near intensity distribution to a real omnidirection. What is necessary is just to produce a light emitting device in the field bearings other than the phase (111) present which are a high order number more to make it still more uniform intensity distribution. Synchrotron orbital radiation is spreading two-dimensional optical waveguide after that, and tells the lightwave signal to other photoelectrical fusion devices.

[0186] The field copies-bound-together-in-one-volume example of a (photo detector) can be used also as a photo detector.

[0187] In drawing 20 or drawing 22 , a reverse bias (for example, 3.3V) is applied to the pn junction of a photoelectrical fusion device by the bias circuit 3301. At this time, this photoelectrical fusion device can receive the lightwave signal which spreads the inside of the two-dimensional optical core layer 3106 from the direction of arbitration. This is because the light-receiving side has the spherical-surface configuration. An input lightwave signal is incorporated inside, is absorbed near the PN junction to which the reverse bias was applied, and is changed into an electronic signal. After the changed electrical signal was amplified to the CMOS logic level by the pre amplifier 3102 which approaches as an input electrical signal (or attenuation) and it is further processed in waveform shaping circuit 3102 grade, it is transmitted to the printed circuit contacted by the bump.

[Translation done.]

DESCRIPTION OF DRAWINGS

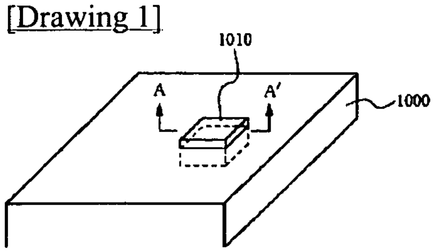
[Brief Description of the Drawings]
[Drawing 1] It is a typical perspective view for explaining the operation gestalt of this invention.
[Drawing 2] It is a typical sectional view for explaining the operation gestalt of this invention.
[Drawing 3] It is a perspective view for explaining this invention.
[Drawing 4] It is a typical sectional view for explaining this invention.
[Drawing 5] It is the typical sectional view of a spherical light device.
[Drawing 6] It is a typical sectional view for explaining this invention.
[Drawing 7] It is drawing for explaining this invention.
[Drawing 8] It is drawing for explaining this invention.
[Drawing 9] It is drawing for explaining this invention.
[Drawing 10] It is drawing for explaining this invention.
[Drawing 11] It is drawing for explaining this invention.
[Drawing 12] It is drawing for explaining this invention.
[Drawing 13] It is drawing for explaining this invention.
[Drawing 14] It is drawing for explaining this invention.
[Drawing 15] It is drawing for explaining this invention.
[Drawing 16] It is drawing for explaining this invention.
[Drawing 17] It is drawing for explaining this invention.
[Drawing 18] It is drawing for explaining this invention.
[Drawing 19] It is drawing for explaining this invention.
[Drawing 20] It is drawing for explaining this invention.
[Drawing 21] It is drawing for explaining this invention.
[Drawing 22] It is drawing for explaining this invention.
[Drawing 23] It is drawing for explaining this invention.
[Drawing 24] It is drawing for explaining this invention.
[Drawing 25] It is drawing for explaining this invention.
[Drawing 26] It is drawing for explaining this invention.
[Drawing 27] It is drawing for explaining this invention.
[Drawing 28] It is drawing for explaining this invention.
[Drawing 29] It is drawing for explaining this invention.
[Drawing 30] It is drawing for explaining this invention.
[Drawing 31] It is drawing for explaining this invention.
[Drawing 32] It is drawing for explaining this invention.
[Drawing 33] It is drawing for explaining this invention.
[Drawing 34] It is drawing for explaining this invention.
[Drawing 35] It is drawing for explaining the conventional example.
[Description of Notations]
1000 Optical Transmission Field

1010 Light Sensing Portion
1101 Photoelectrical Fusion Substrate
1102 Two-dimensional Optical Waveguide Layer
1103 Electron Device
1104 Electric Wiring
1105 Optical Wiring
1106 Electron Device
1107 Electron Device
1108 Electric Wiring Field
1109 Support Substrate
1201 Light Sensing Portion
1202 Metal Bump
1501 Spherical Member
1502 1st Cladding Layer
1503 Barrier Layer
1504 Cathode
505 Anode
506 Beer Hall

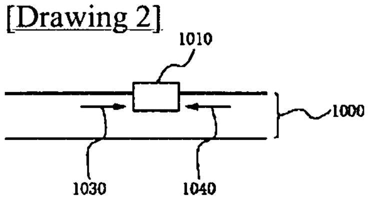
[Translation done.]

DRAWINGS

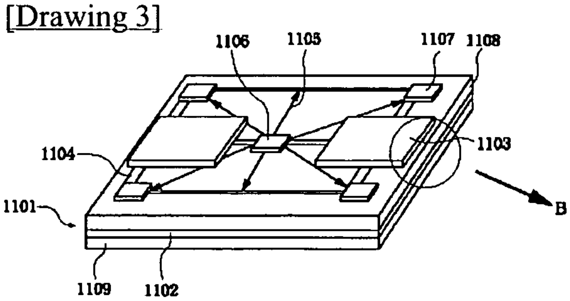
[Drawing 1]



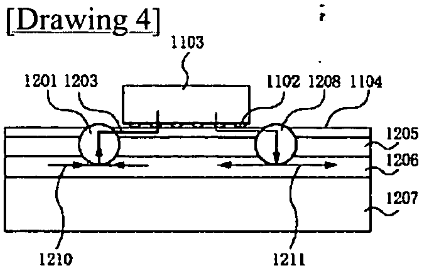
[Drawing 2]



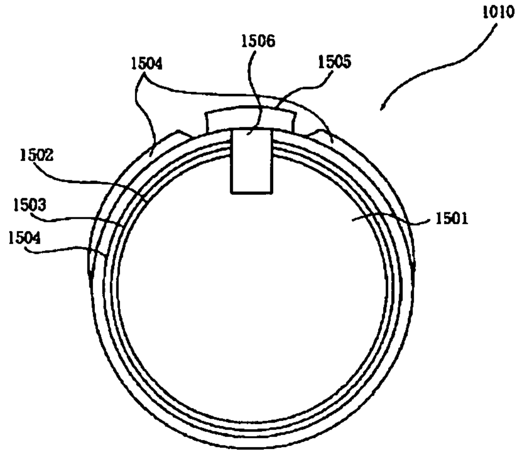
[Drawing 3]



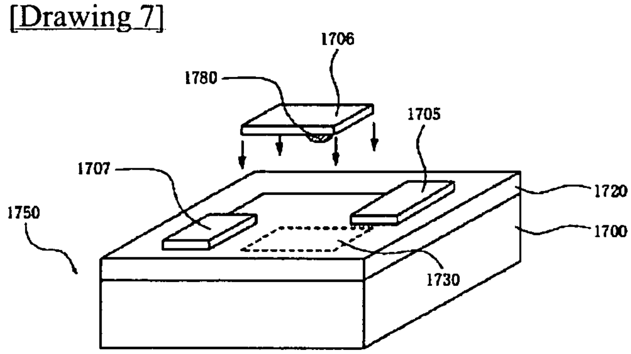
[Drawing 4]



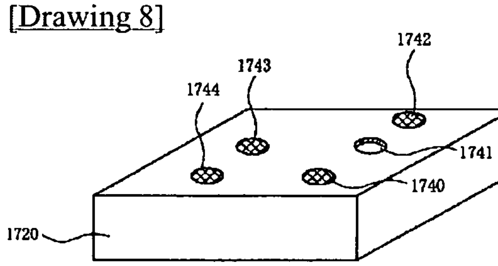
[Drawing 5]



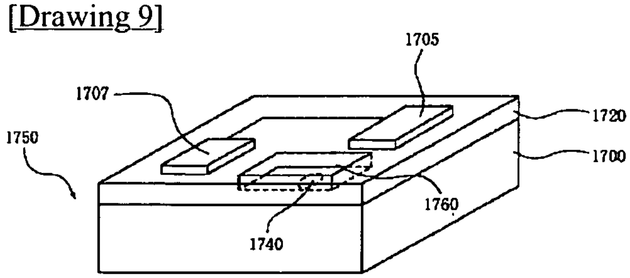
[Drawing 7]



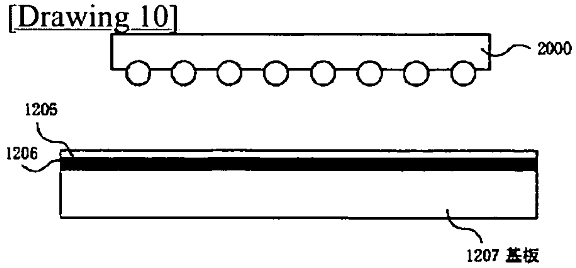
[Drawing 8]



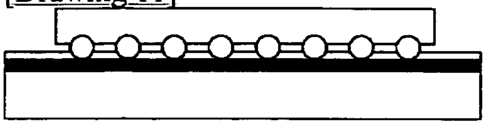
[Drawing 9]



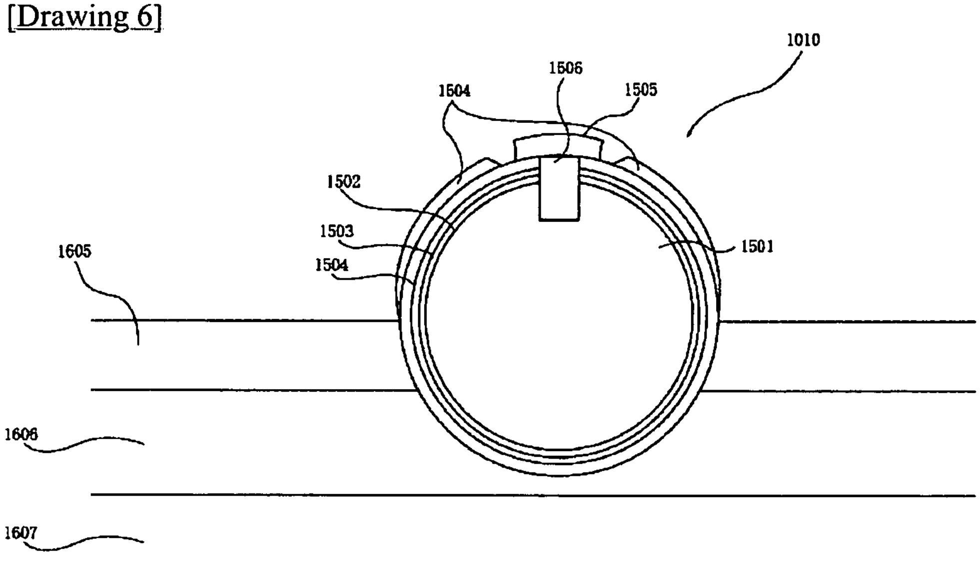
[Drawing 10]



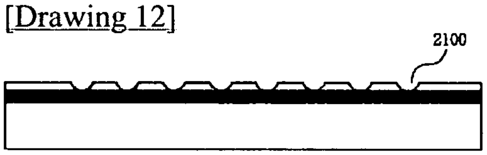
[Drawing 11]



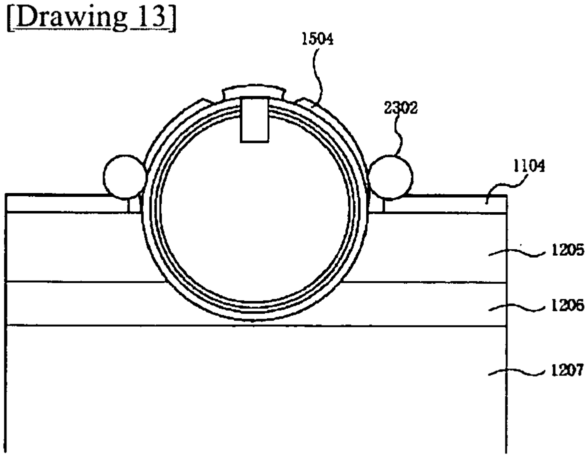
[Drawing 6]



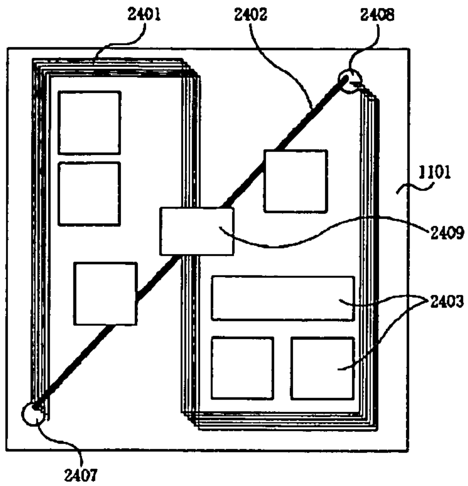
[Drawing 12]



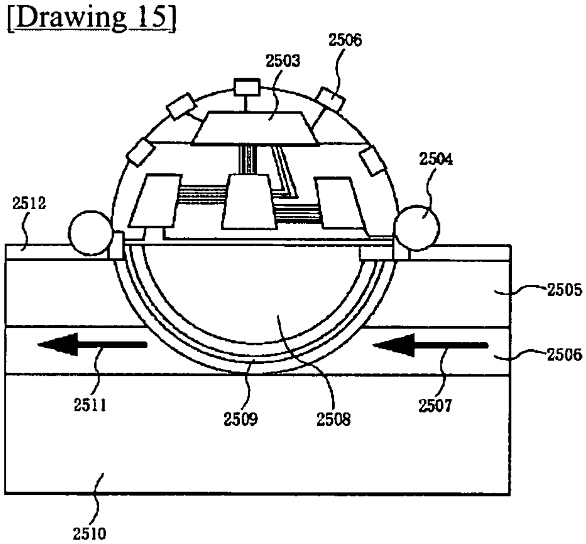
[Drawing 13]



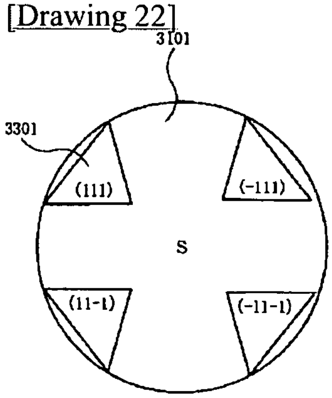
[Drawing 14]



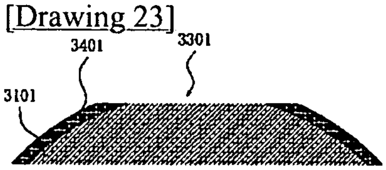
[Drawing 15]



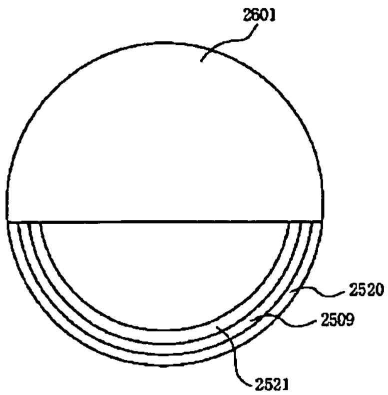
[Drawing 22]



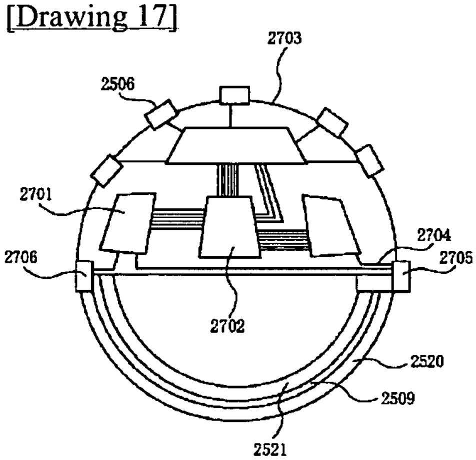
[Drawing 23]



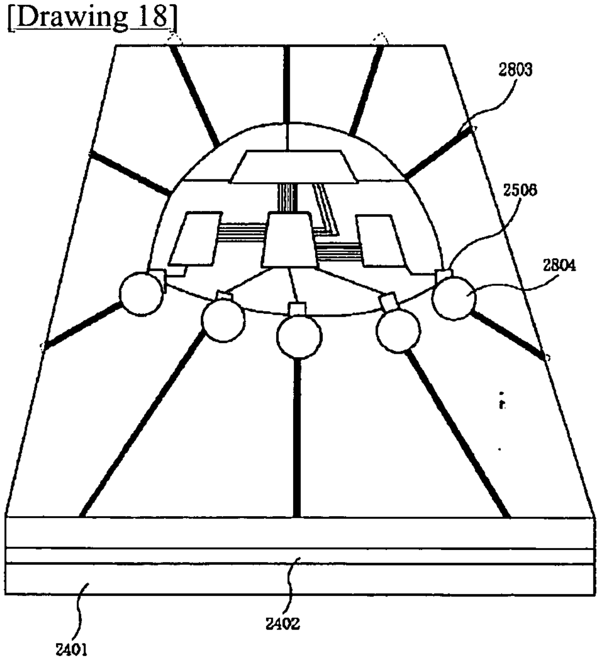
[Drawing 16]



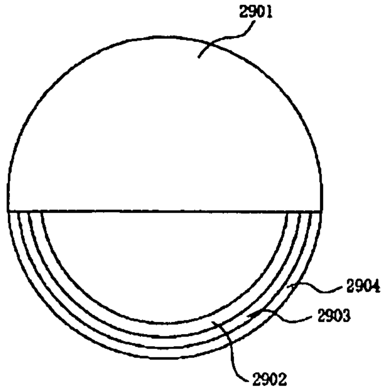
[Drawing 17]



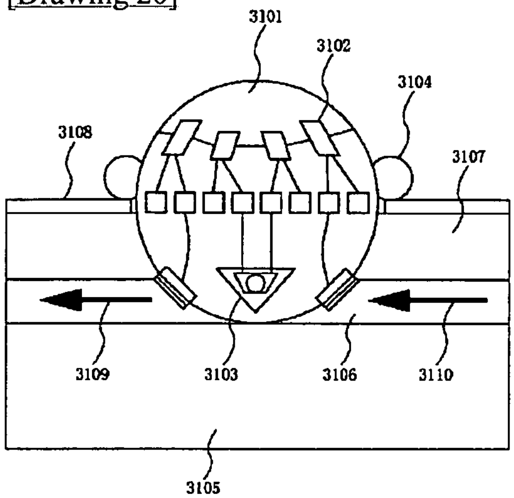
[Drawing 18]



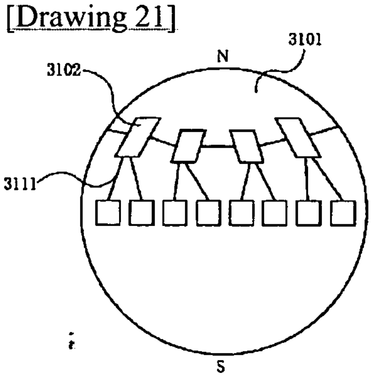
[Drawing 19]



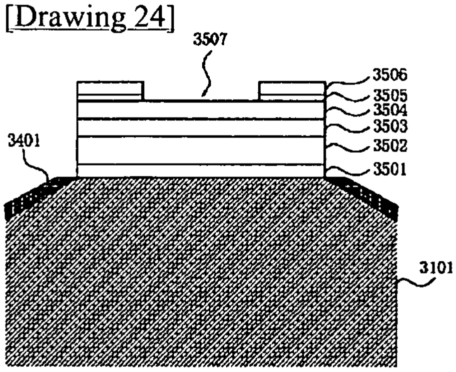
[Drawing 20]



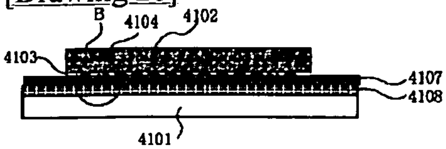
[Drawing 21]



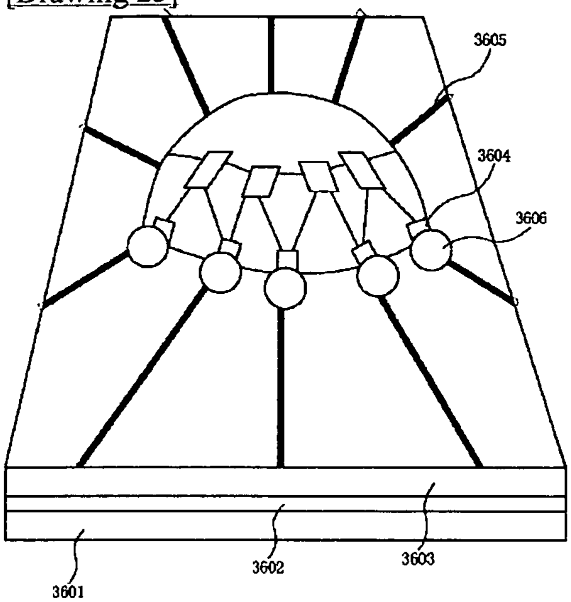
[Drawing 24]



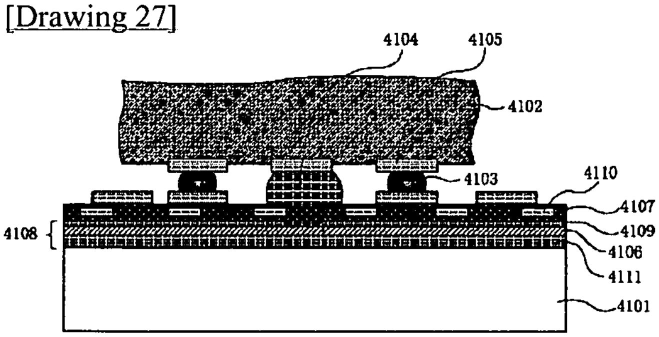
[Drawing 26]



[Drawing 25]

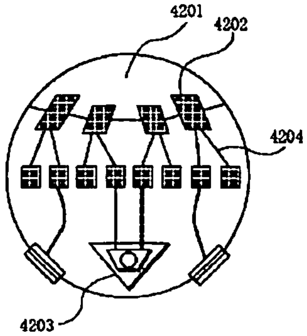


[Drawing 27]



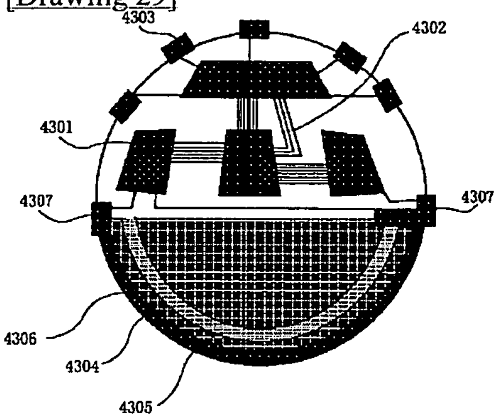
4101 保持基板
4102 ICチップ
4103 ハンダボール(バンプ)
4104 フォトニックボールIC
4105 電極パッド
4106 コア層
4107 電気配線層
4108 光配線層(光フィルム)
4109 クラッド層
4110 マイクロストリップライン

[Drawing 28]



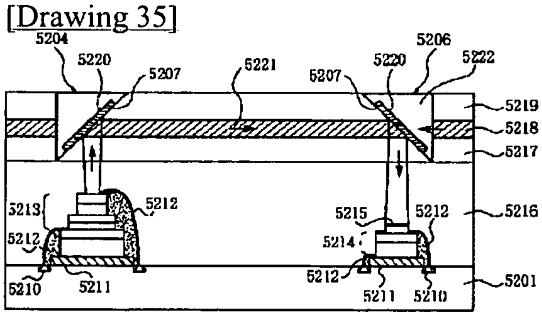
4201 球状半導体基板
4202 IC
4203 光デバイス
4204 電気配線

[Drawing 29]

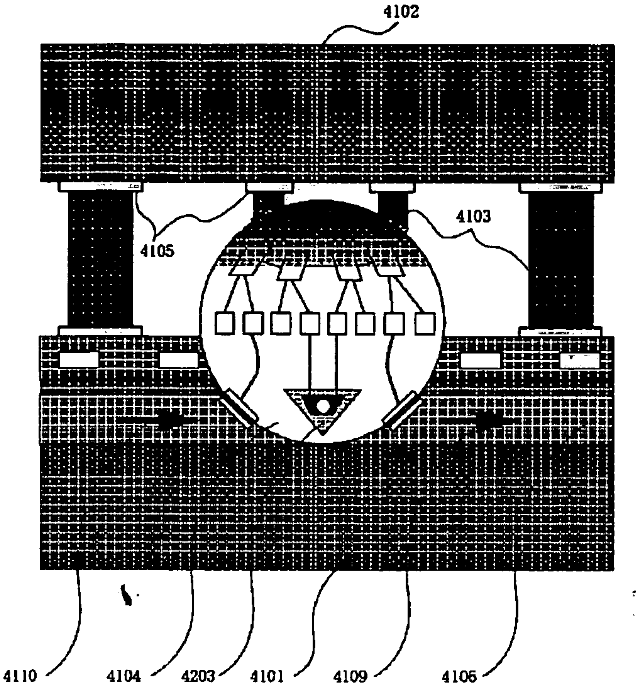


4301 電子回路
4302 電気配線
4303 電子回路用電極パッド
3404 クラッド層
3405 活性層
4306 コンタクト層
4307 光デバイス用電極パッド

[Drawing 35]

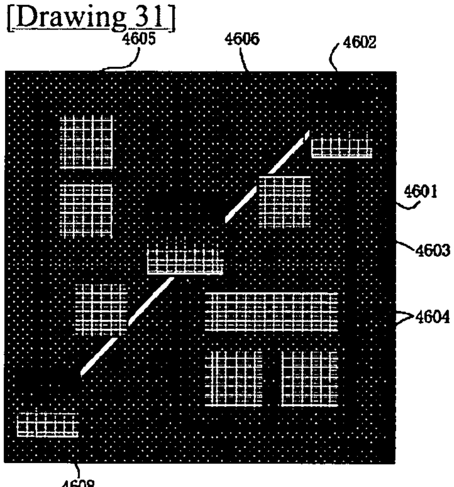


[Drawing 30]



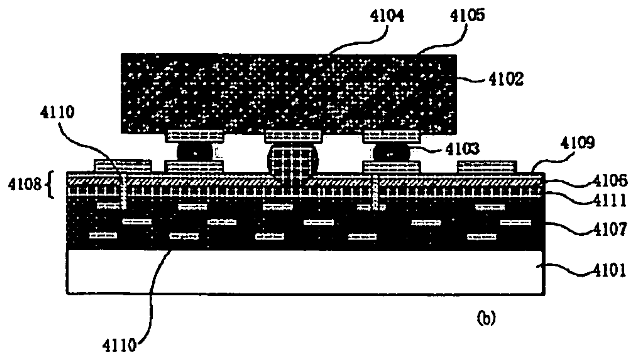
4101 保持基板
4102 IC
4103 バンプ
4104 フォトニックボールIC
4105 電極パッド
4106 コア層
4107 クラッド層
4108 光配線層（光フィルム）
4109 出力光
4110 入力光
4111 EO/OEデバイス

[Drawing 31]



4601 光電融合基板
4602 CPU
4603 メモリ
4604 その他LSI
4605 パラレル電気配線
4606 シリアル光配線

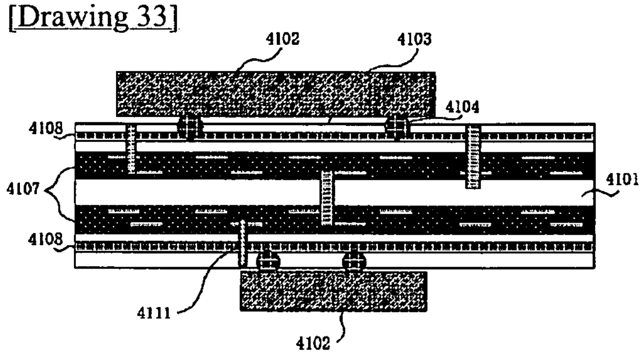
[Drawing 32]



(b)

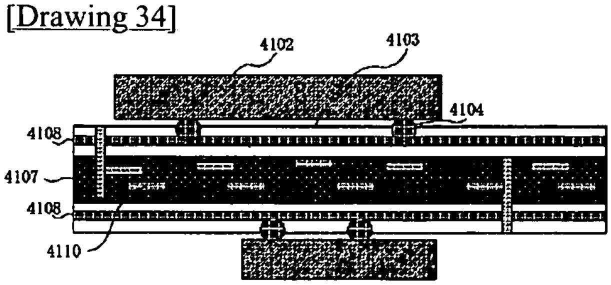
4101 保持基板
4102 ICチップ
4103 ハンダボール(バンプ)
4104 フォトニックボールIC
4105 電極パッド
4106 コア層
4107 電気配線層
4108 光配線層(光フィルム)
4109 クラッド層
4110 内部配線
4111 ビア

[Drawing 33]



4101 保持基板
4102 LSI
4103 バンプ
4104 フォトニックボールIC
4107 電気配線層
4108 光フィルム
4110 内部配線
4111 ビア

[Drawing 34]



4102 LSI
4103 バンプ
4104 フォトニックボールIC
4107 電気配線層
4108 光フィルム
4110 内部配線
4111 ビア

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[Translation done.]